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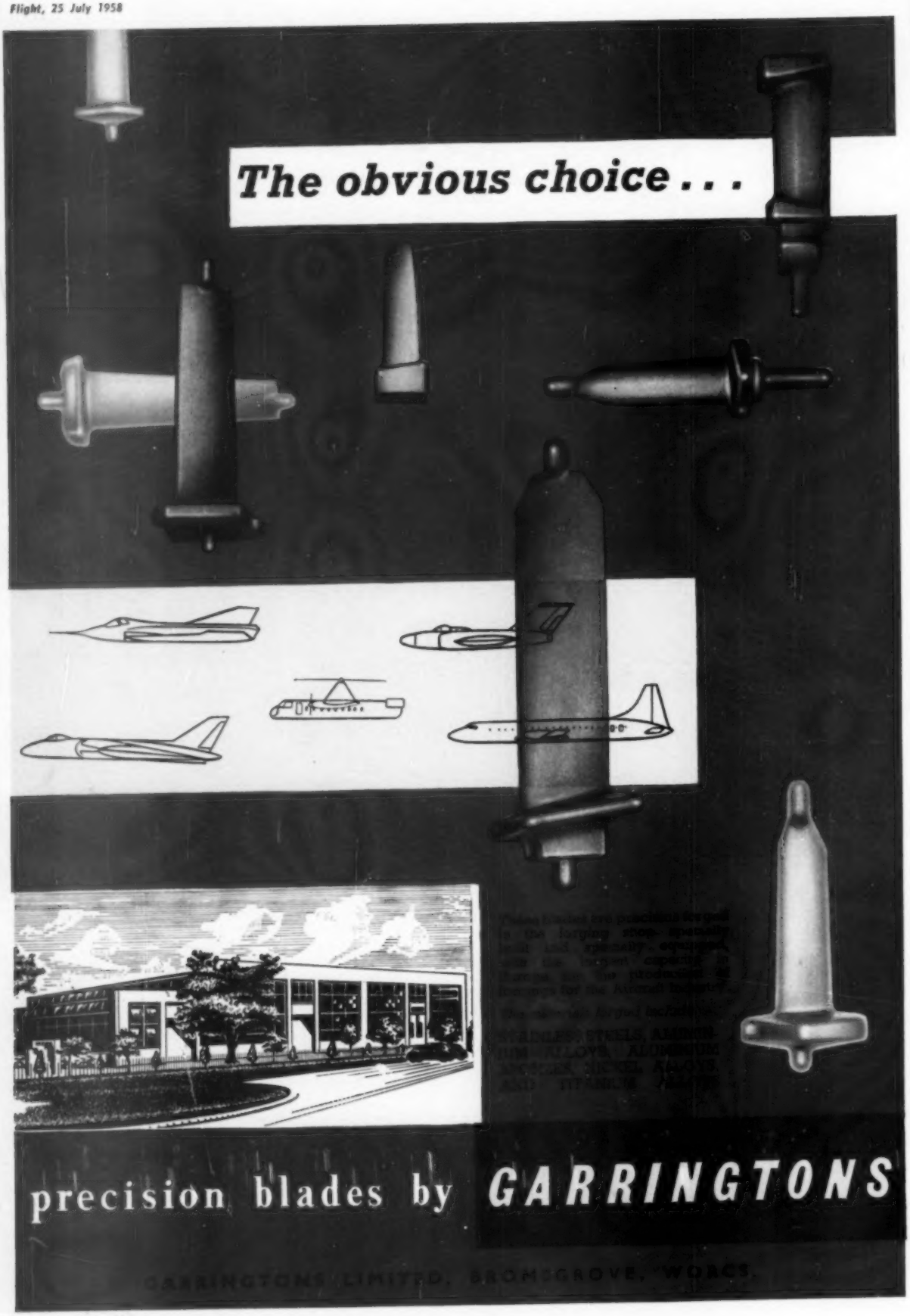
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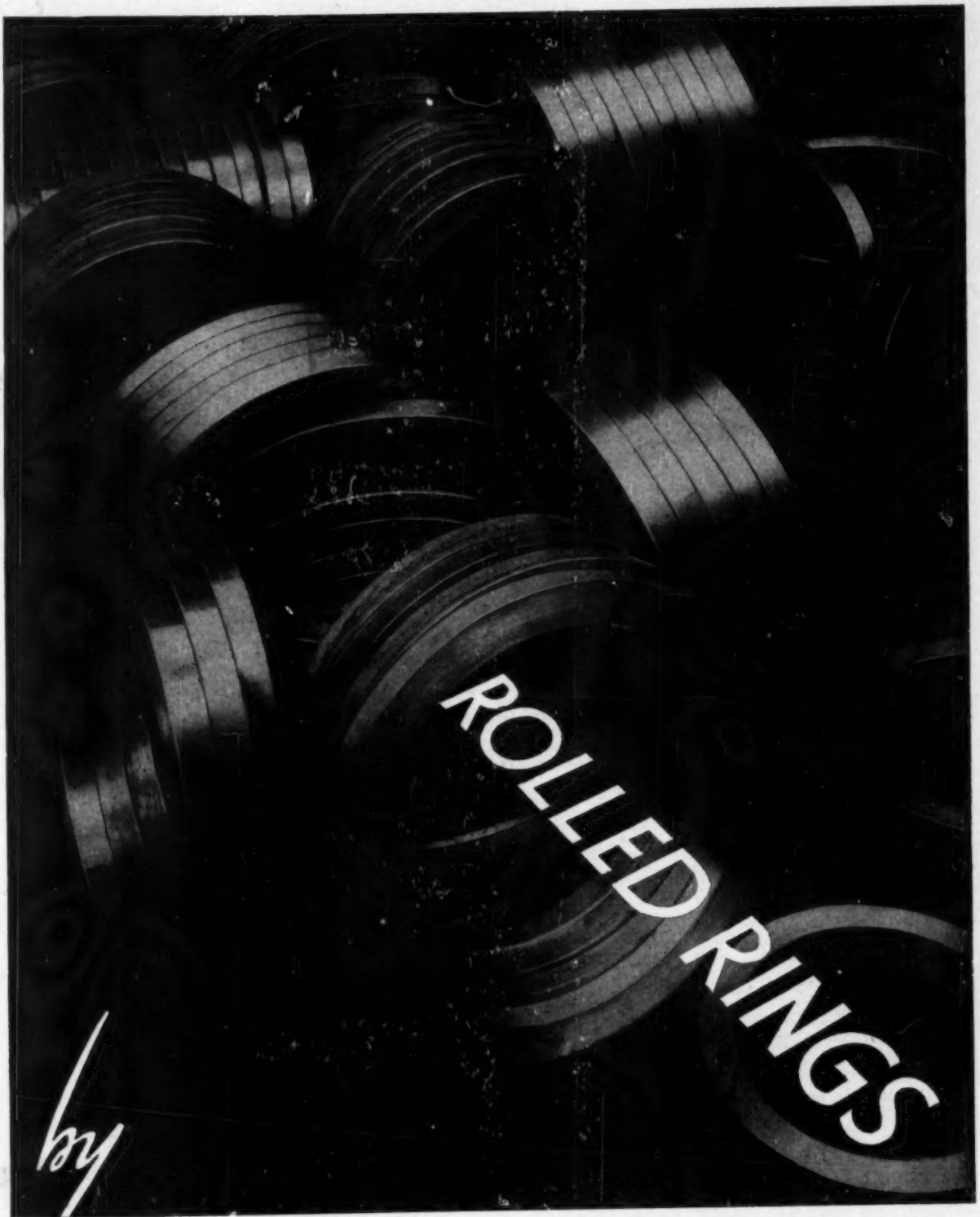
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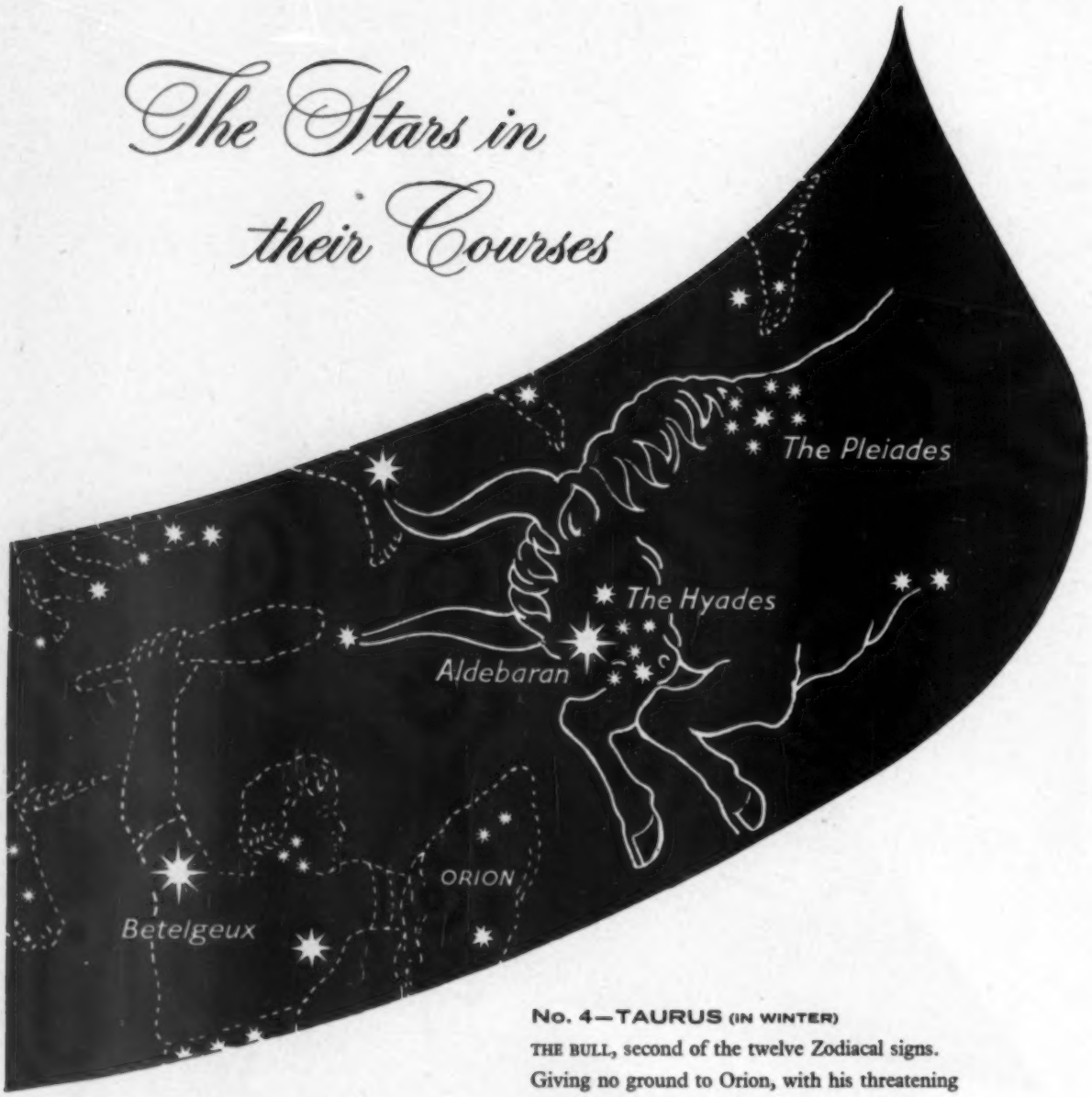

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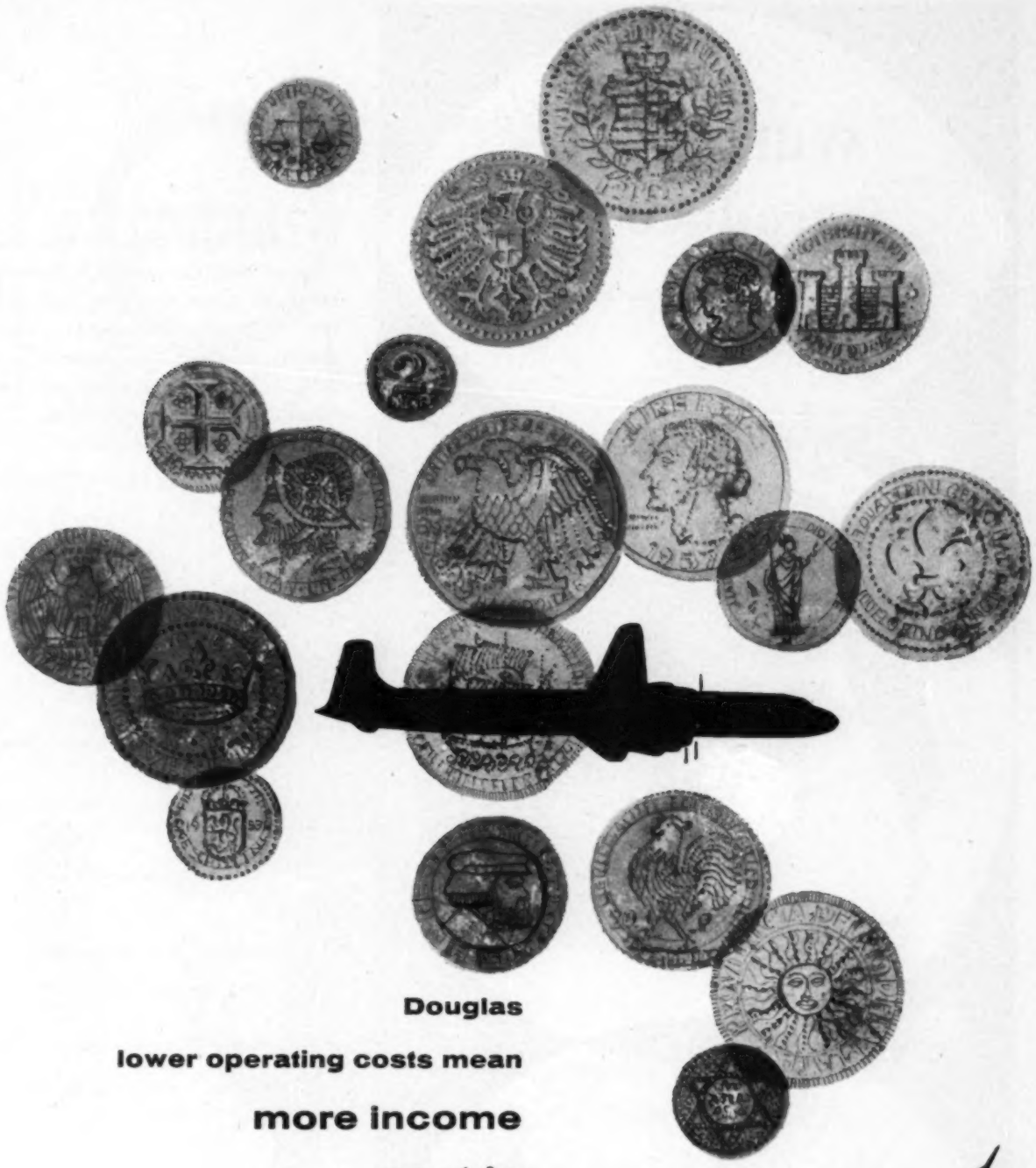

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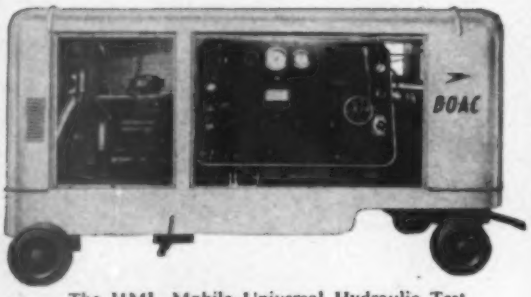

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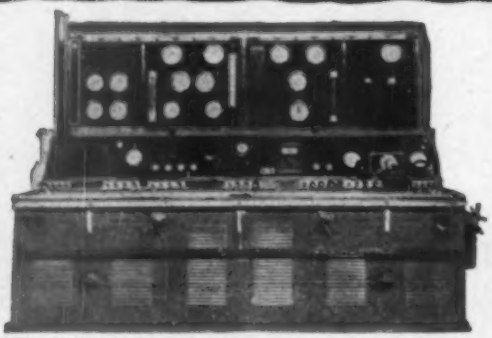

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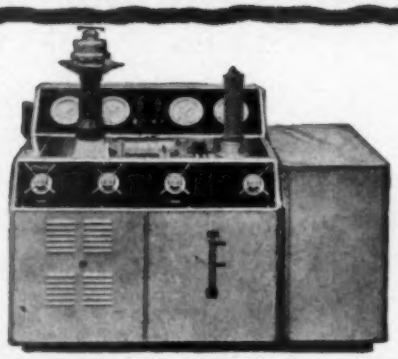

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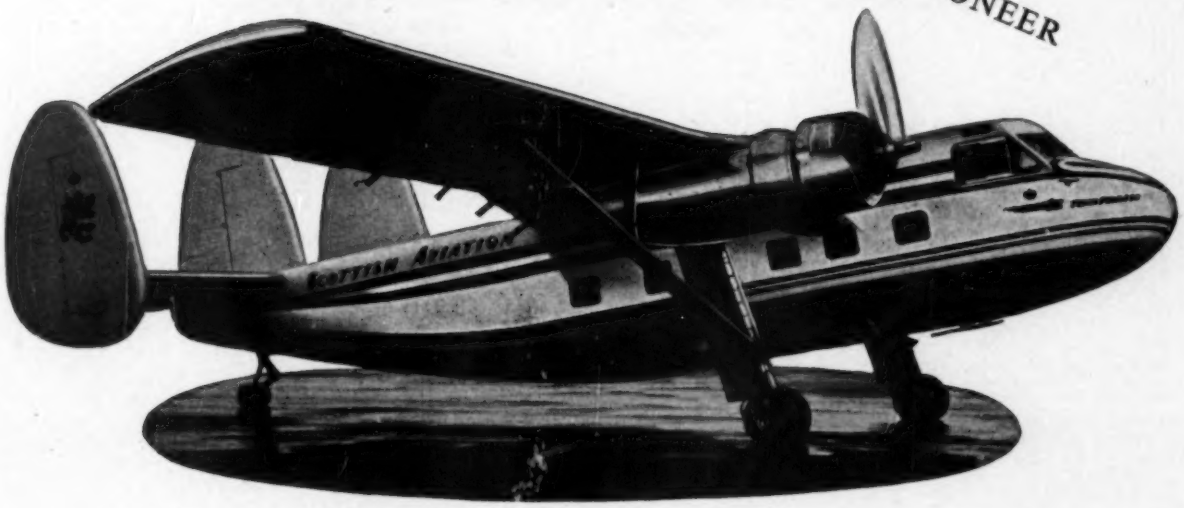

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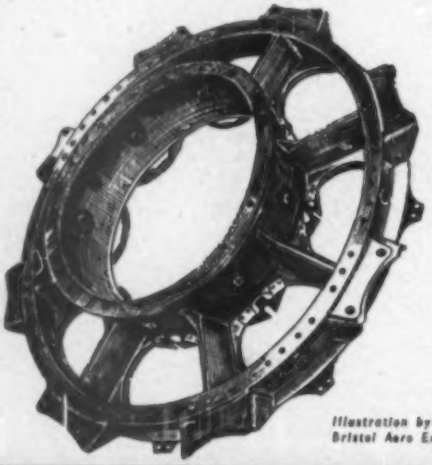

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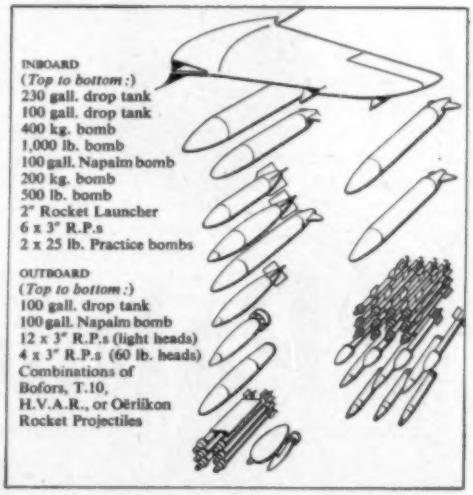

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FLIGHT
and
AIRCRAFT ENGINEER

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The Lords, the Industry . . .

NOBODY who reads with care the House of Lords *Hansard* for July 16 will subscribe to the view that the Upper House should be done away with lock, stock and barrel. For the views put forward that afternoon on the aircraft industry were some of the most sensible and authoritative yet offered in public debate on this much-discussed subject. Considering the participants, one would have expected no less; for among the speakers were former Ministers for Air and Civil Aviation, the chairman and a director of Vickers, the chairman of Rolls-Royce and the chairman of the A.R.B.: practically all, in fact, men who know their subject at first hand. Further, there was an almost complete absence of party politics. As Lord Swinton put it: "Here you have men of wide experience, administrators, manufacturers and scientists, merely determined to see what is the wisest policy for this industry."

Underlying many of the speeches, however, was the feeling that—as Lord Pakenham put it—there is "scepticism and anxiety" in the industry as to its future; though, as Viscount Knollys said, there is no "spirit of defeatism." Some pertinent questions were put by Viscount De L'Isle when he opened the debate (extracts are given on p. 99), and some trenchant facts were quoted by Viscount Knollys and Lord Kindersley—that unless some help were given to aircraft firms the number of employees might fall below the 150,000 figure given by the Minister of Supply; that Vickers had already provided £4m out of their own resources for development and tooling of the Vanguard; and that it cost anything up to £20m and had been known to take ten years to develop a new engine.

. . . and the White Paper

The whole discussion had, of course, as its background the *White Paper on Defence* of 1957 and the effect upon the industry of the Governmental decision to reduce future procurement of military aircraft. It was clear from what was said that the industry feels it needs not only more financial help from the Government—in the face of the tremendous costs of development and increasing competition in civil aircraft from the U.S.A. and the U.S.S.R.—but a clearer definition of Government policy. As Lord Swinton said: "Let the industry know now, as soon as you can. Certainty and security are vital. . . ." Or as Lord Ogmore put it: "The industry is rudderless." Various suggestions were made as to what form this guidance and aid should take and how it should be administered—a more effective Ministry of Supply, a high-level sub-committee, an independent "air tribunal," a Corporation analogous in standing to the Bank of England. Lord Mancroft in his summing-up took his stand on the working party which is "looking into" the industry, and on the high-minded but necessarily abstract idea of "partnership" between Government and industry. But it was significant that Viscount De L'Isle, in a rather sad closing speech, said he would go away as depressed as he came. Eighteen months after last year's *White Paper* major points were still undecided. Our competitors were going ahead while we waited upon decisions which should have been taken months, if not years, ago.

Surely it is now up to the industry, which has seldom spoken with one unequivocal voice, to tell the Government exactly what it does want? And why does not the Government, instead of setting up working parties (or, as was suggested, some kind of permanent independent body), simply call together the industry's leaders and get them to state their views at one go? The House of Lords debate has provided a good precedent for such a round-table discussion. Everything is to be gained by complete frankness on both sides. Once the Government has heard the industry's views completely and officially, it should then say—with the minimum of delay—what it is prepared to do. Scepticism and anxiety should then recede before assurance and optimism.

FROM ALL QUARTERS

HENRY FARMAN, one of the great designer/pilots of all time, whose death is recorded on this page. This "Flight" photograph portrays him, characteristically, in 1913.

M.E. Airlifts

BRITISH airlifts from Cyprus to Jordan, from the United Kingdom to Cyprus and from Kenya to Aden, and American airlifts from Germany and the U.S.A. to Turkey and the Lebanon, were successfully completed last week in connection with the Middle East emergency.

The largest British operation—the movement of 2,000 troops of the 16th Independent Parachute Brigade and their equipment, plus R.A.F. personnel, 250,000 lb of stores, 6,000 gal of fuel and 120 vehicles and trailers from Cyprus to Amman—was carried out on July 17 and 18 by R.A.F. Beverleys and Hastings, eighty sorties being flown in 24 hr to complete the airlift. Hunter 6s of No. 208 Sqn. from Nicosia provided air cover and Hunters of No. 54 Sqn. have flown out from R.A.F. Odiham to Nicosia in support.

R.A.F. Comets and Valettas have also been employed in the transport of men and supplies, in addition to the Beverleys and Hastings, a total of 38 transport aircraft being sent out between July 14 and 16 to reinforce the M.E.A.F. squadrons. These reinforcements included 12 Hastings (from Lyneham, Colerne and Dishforth, supplementing those of No. 70 Sqn.), and four Valettas from Benson. There were 17 Beverleys engaged on the Cyprus-Jordan airlift, five already based at Nicosia and twelve flown out from Abingdon and Dishforth. Five Comets—three sent from the U.K. and two diverted from the Britain-Singapore trunk route—were positioned at Nairobi to fly troops to Aden and Bahrain. The task force is under the command of G/C. T. N. Stack, who flew to Nicosia by Comet on July 16 with the Transport Command mobile operations centre.

In addition to the airlifts by Service aircraft, 150 R.A.F. personnel were flown out to Cyprus last Friday and Saturday from London Airport (by B.O.A.C. Britannias) and from Stansted, Essex, by Hermes aircraft of Skyways, Ltd., the latter company also transporting men of the 19th Army Brigade.

Defence Changes

UNDER the changes in defence organization announced by the Prime Minister on July 15 and published as a White Paper, the chairman of the Chiefs of Staff Committee, Marshal of the R.A.F. Sir William Dickson, becomes Chief of the Defence Staff; the composition and operation of the Cabinet's defence committee is being adjusted to secure greater flexibility and efficiency; and a Defence Board is being set up to assist the Minister of Defence in formulating defence policy and dealing with inter-Service problems.

The Minister, Mr. Duncan Sandys, has now been made "ministerially responsible to the Prime Minister for the execution of military operations approved by the Cabinet or the Defence Committee"; but his authority to give decisions on pay and conditions has been taken away, Service ministers again being responsible for these.

The Chiefs of Staff will continue to act collectively to give their military advice to the Minister of Defence and the Government; but where there are differences between the Chiefs of Staff the Chief of the Defence Staff will not merely report these but will tender his advice.

RETIRED BANDIT who still likes to keep a bit of hardware about the person is this ageing Bristol Brigand of the Air Torpedo Development Unit, Culdrose. Three homing torpedoes are carried.

Henry Farman

WITH the death of Henry Farman in Paris on July 17, at the age of 84, a revered pioneer passed from the aeronautical scene.

Henry Farman was born on May 26, 1874, and the question of his nationality was the subject of a recent *Flight* "Correspondence" letter (April 11, 1958) from Charles H. Gibbs-Smith. Mr. Gibbs-Smith's researches showed that Farman was a British subject until 1937, when he became a naturalized Frenchman. Thus he was the first Briton to fly in a powered aeroplane and the first Briton to become a powered-aeroplane pilot—in fact, the first of all British aviators, if gliding is excluded. Mr. Gibbs-Smith continued:—

"If we pass over his tentative hops during September 1907, we can mark October 1907 as the month of his first powered and sustained flights (including one at Issy of 2,530ft on October 26), and January 1908 as the month of his first powered, sustained and controlled flying, in that he made the first officially observed kilometre circuit on January 13, and so won the Prix Deutsch-Archdeacon. Henri Farman was also the first true and proper powered aeroplane pilot of Europe. Santos Dumont's best 'flight' in 1906—when he was adjudged to have made the first powered flights in Europe—was only some 720ft, after which he speedily abandoned his ingenious but unpractical and virtually uncontrollable aircraft, and did not make a significant aeroplane flight of any kind until 1909. Furthermore, neither Delagrange nor Blériot, despite their good efforts in 1907, were able to fly properly until well into 1908. For the academic, it should be said that one finds Farman's Christian name spelt both 'Henry' and 'Henri' during 1907 and 1908, with 'Henri' appearing on the tail-unit side-curtains of his Voisin biplane, and on his own designed machines of 1909."

It was in 1909 that Farman came to England for the Blackpool meeting, where he won prizes for length of flight and speed. Thereafter biplanes of his design increasingly became a classic type. In 1912 Henry Farman entered into a business association with his brother Maurice, and aircraft by both these famous designers were extensively used in the First World War. The firm then turned increasingly to large passenger aircraft and bombers, their most notable design being the Goliath, which was so familiar on the Croydon-Paris run in the 1920s.

In 1936, under the French Government law for nationalization of the aircraft industry, the identity of the name Farman was submerged in the Société Nationale de Constructions Aeronautiques du Centre, wherein the company was associated with the Hanriot concern. The last Farman designs were large four-engined bombers and transports. Both brothers retired from the business in 1937.

Hunters for Holland

ON July 18 the first two Hunter Two-Seaters of the order placed with the Hawker Siddeley group by the Dutch Ministry of War for the Royal Netherlands Air Force were flown to Holland from the Hawker airfield at Dunsfold, Surrey.

Atlas with Sustainer

FLIGHT trials with the SM-65 Atlas intercontinental ballistic missile moved into the final stage on July 20 when the first round was fired with all three engines operating. Earlier flights had been of limited-range (500 miles) vehicles with two boosts only and no sustainer. Although not programmed for the full 6,330 miles, the July 20 vehicle had a sustainer and should have travelled over 1,000 miles. A control malfunction, however, apparently caused wild gimballing of one or more motors and the airframe broke and then exploded after 45 sec.

The Tushino Display

CIVIL aviation was the theme of the celebrations, in connection with the Soviet All-Union Aviation Day, held at Moscow's Tushino Airport on July 20. "Uncounted thousands" were said to have packed the airport and the country around to watch the display, which lasted 2½ hours. About half the participating pilots were women.

The display began with a fly-past and aerobatics by gliders, including one of the familiar "air trains," in which a number of tugs each towed twelve gliders. This was followed by several helicopters, two of which carried trapeze performers. The same group included the Soviet "flying bedstead" (see picture, facing page) named by the radio announcer alternatively as "the flying saloon" or "the flying table."

A number of Yak-18 trainers then appeared, playing what was termed "air football," i.e., they were bursting balloons. Following them came nine other Yak-18s, flown by women, which performed aerobatics and changed formation. Then still more Yak-18s—19 this time—forming a continuous follow-my-leader circle at low altitude. In contrast came the gigantic Tu-114, capable of carrying

220 passengers to Vladivostok or New York, and this was followed by a Tu-104. When these disappeared the stage was taken by the Il-18 and the Pchelka (Bee). The final item was the release of 288 parachutists using multi-coloured canopies, who "shook hands in the air" as they descended.

On the previous day Moscow radio had reported that "Soviet designers, working on new problems of aircraft construction, are developing various engines for flying in the stratosphere at a speed of two to four times above that of sound." This was stated by Lieutenant-General of Aviation Andrei Rytov. The General added that along with manned aircraft the Soviet Air Force is beginning to lay emphasis on pilotless aircraft, thus greatly extending the combat potential of the Armed Forces.

G.91 Operational Trials

SEVERAL Fiat G.91 light fighters have now been delivered to an airfield in central Italy, where the Italian Air Force is to carry out a series of intensive operational trials. The AGARD committee and representatives of SHAPE and AIRCENT recently visited the unit and also went to Turin to see progress with production and the construction of the G.91R and G.91T prototypes. A new version, called the G.91N and fitted with special navigational equipment, has now been officially mentioned.

The P.531 Flies

THE new Saunders-Roe P.531 helicopter, powered with a Blackburn Turboméca Turmo 600 series free turbine and piloted by K. M. Reed, the manufacturer's senior helicopter test pilot, made a successful first flight—followed by a second—from Southampton

FIRST FLIGHT of the Saunders-Roe P.531 helicopter, above, was made from Eastleigh last Sunday, July 20 (see accompanying news item).

Airport, Eastleigh, last Sunday. This five-seater is being developed as a private venture and was first illustrated in *Flight* of July 4.

In charge of design was Mr. T. L. Ciastula, Dipl.Ing., A.M.I.Mech.E., A.F.R.Ae.S., chief designer of Saunders-Roe's helicopter division.

Blackburn B.107 and NA.39

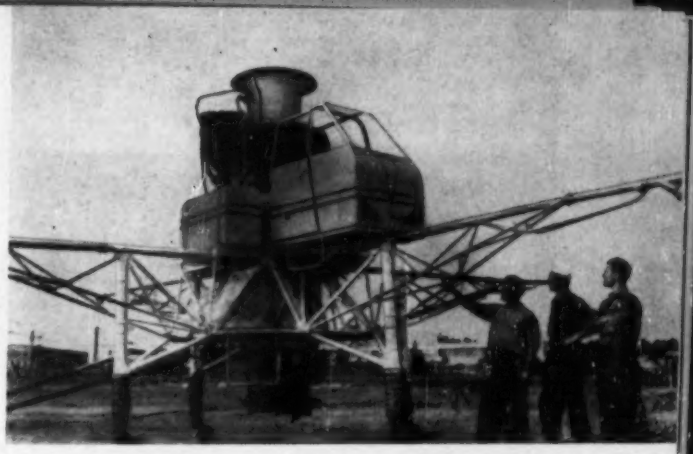
IN his review of Blackburn and General Aircraft results and prospects, issued in advance of the annual general meeting to be held on August 11, Mr. Eric Turner (chairman and managing director) says that there are good prospects of the company having "an attractive programme" for a number of years. The Beverley, he says, is showing its great versatility in service, and a replacement for it—the B.107—is projected. "I am disappointed that we have not yet been asked to develop the Beverley to give it longer range, greater speed and lifting capacity," commented Mr. Turner, "but the need for such an aircraft as quickly as possible in R.A.F. Transport Command is still so clear and unequivocal that we are continuing with our design work on a private venture basis."

Referring to the NA.39, the chairman says that it is hoped that before the a.g.m. an initial production order will have been placed for the Royal Navy.

The company's financial results show a slightly increased profit for the financial year ended March 31. The balance after all charges other than taxation was £1,025,013 (compared with £1,018,491 in 1956-57) and net profit £547,104 (£514,356).

National Gliding Week

THIS year's National Gliding Week—a new contest organized by the British Gliding Association—is being held from next Sunday (July 27) until August 4 in three regions. These are London (the contest for which will be at Dunstable, Beds); Western (Nympsfield, Glos); and Scottish (Portmoak, nr. Kinross). A total of 42 gliders—20 at Nympsfield, 14 at Dunstable and eight at Portmoak—and 71 pilots have been entered.



THE FLYING SALOON was one of the names used by the Russian commentator to describe this Soviet "bedstead" VTO test rig when it appeared at the Tushino display on July 20. The device is ascribed, in one Soviet report, to A. Raphaelants.

Cornish Air Day

FOR the first time since 1955, R.N.A.S. Culdrose's annual air day, held last Saturday, had good weather. A static Sea Hawk appropriately welcomed visitors at the gate of the station—H.M.S. *Seahawk*, home of the Air Observer Air Signal School, the Naval Aircraft and Ship Recognition School, and the Air Torpedo Development Unit. Soon these will be joined by the School of Aircraft Handling and by 727 Squadron from Brawdy.

The display was opened by Sir Egbert Cadbury (one of the first pilots to shoot down a Zeppelin), accompanied by the commanding officer, Captain H. S. Barber. Among the guests was the Russian Naval Attaché.

Two Dragonflies having winched up a camera crew from a highly pyrotechnic taxi, the way was clear for a stream take-off by 25 aircraft—a Sea Balliol leading 16 Gannets of 796 Squadron (Observer School), four Avengers of 831 Squadron (Radio Countermeasures Unit) and four Skyraiders of 849 Squadron. Balliol aerobatics were followed by demonstrations of Fairey's Fulmar (Peter Twiss) and of a Scimitar from Ford. Now, in formation, passed the Gannets, Avengers and Skyraiders, the 16 Gannets in sections of four, line abreast, the eight others in a similar formation. The block of Gannets made a magnificent sight, and below an A.S.R. Whirlwind began to put in its demonstration as the formations dispersed. An Olympia sailplane of the Cornish Flying and Gliding Club provided a quiet interlude, and the Royal Marine Commandos from Plymouth demonstrated parachute descents from a barrage balloon.

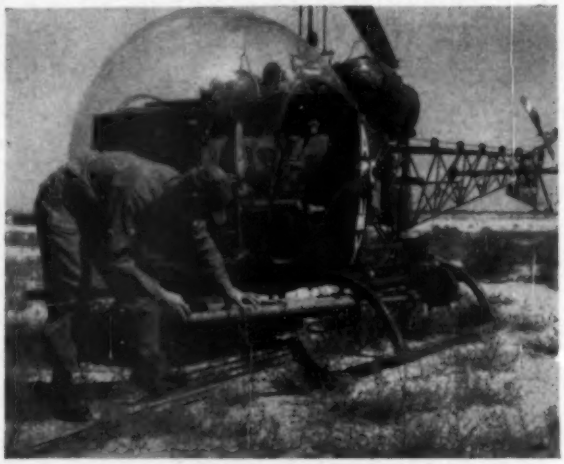
The tea interval permitted examination of statically parked aircraft, including a Shackleton MR.3 of No. 206 Squadron and the A.T.D.U.'s Brigand, see photograph on opposite page. Two similar weapons were shown under a Gannet in the hangar display.

The C.F.S. Jet Provosts opened up the second half of the show, concluding with a deck-level exit across the rolling contours of Goonhilly Downs. A stirring performance by the A.T.D.U. Canberra was followed by a similar rendering by a Hunter. A Victor passed by in two runs, giving way to a Spitfire (Jeffrey Quill), whose performance was sheer delight. There followed the Shackleton and a delayed drop by Peter Lucas from a Tiger Moth piloted by his father—W. Lucas, the Plymouth Airport manager. Finally, four Sea Venoms from Yeovilton attacked a static Seafire—supposedly to provide action for the station's fire engines. But the fire misfired, so it was a cold-foam job after all.

CERES is the name of this new agricultural aircraft built by the Commonwealth Aircraft Corporation of Australia. A first production batch of 40 has been laid down; cost per aircraft will be about £A14,000. Load is 2,000 lb of dust or 250 gal of spray, and slats and slotted flaps are fitted.

SPIKY DRAGONS: A recent picture of Saab-35A (J35A) single-seat all-weather fighters. The type will go into service with the Royal Swedish Air Force about a year from now.

SHOOTING FROM THE HIP: A Bell H-13H (below) armed with two 0.30in machine guns and six 2in rockets. Other helicopters of this type have appeared with as many as four machine guns.



FROM ALL QUARTERS . . .

Rolls-Royce Directorships

INVITATIONS to join the Board of Rolls-Royce, Ltd., have been accepted by Mr. F. T. Hinkley, B.Sc., M.I.Mech.E.; Mr. A. A. Lombard, F.R.Ae.S.; and Mr. J. L. E. Smith, M.A.

Mr. Hinkley, who has been a director of Rolls-Royce of Canada and Rolls-Royce of Australia since 1957, has travelled very widely on behalf of the company. He joined its design staff in 1932, working first on the Kestrel and Merlin; he was appointed assistant chief designer of the aero-engine division in 1940 and chief designer in 1944, being closely associated with Dart development. In 1955 he became general manager, sales and service, aero engine division, and in this post has played a large part in building-up its worldwide sales and service organization.

Mr. Hinkley. *Mr. Lombard.*

Mr. Lombard joined Rolls-Royce from the Rover Co. in 1943 as chief designer, Northern factories, and he was at the company's Barnoldswick establishment until 1946—during the period when the Derwent, Nene, Tay and Clyde engines were designed and design of the Avon was started. He moved to Derby in 1946 following his appointment as chief designer, projects; in 1949 he became chief designer of the aero-engine division and the following year was appointed its chief engineer.

Mr. J. L. E. Smith has been with Coutts and Co., the bankers, for ten years and is a director of that company. He is also on the Boards of the Australian Agricultural Co.; the Solartron Electronic Group, Ltd.; Royal Exchange Assurance; Industrial and General Trust; Sterling Trust; and the Ottoman Bank. He is also a Commissioner of Income Tax.

Dr. Edward Warner

WE regret to record that Dr. Edward Pearson Warner, who was president of the council of I.C.A.O. from 1945 to 1957, died recently at the age of 63 following a heart attack at his home at Duxbury, Mass.

Dr. Warner, whose experience of aviation went back to 1917 (when he became an instructor in aeronautical engineering at Massachusetts Institute of Technology) and covered all its aspects, was a distinguished leader in aviation and it was largely his preparatory work that brought into being the International Civil Aviation Conference in 1944.

During his long career he held government, civil aviation, academic and editorial appointments and wrote several books. From 1926 to 1929 he served in the Coolidge Administration as Assistant Secretary of the Navy for Aeronautics and in 1934 he was appointed by President Roosevelt to membership of the Federal Aviation Commission, of which he became vice-chairman; he was a member and vice-chairman (1939-45) of the C.A.B.; associate professor (1920-24) and later professor (1924-26) of aeronautical engineering at M.I.T.; editor of *Aviation* from 1929 to 1934; and author of books whose titles included *Aerostatics* and *Airplane Design-Aerodynamics*.

Among Dr. Warner's many distinctions were the award to him of the Daniel Guggenheim Medal (1949); his Wilbur Wright lectureship at the Royal Aeronautical Society (of which he was made an honorary fellow) in 1943; and honorary fellowship of the Institute of the Aeronautical Sciences, of the Aeronautical Society of India and of the Canadian Aeronautical Institute.

Battle of Britain Association

DUE to be officially inaugurated yesterday (July 24) at a reception in the R.A.F. Reserves Club, where it will have its headquarters, a Battle of Britain Fighter Association has been formed with Air Chief Marshal Lord Dowding as president. Air Chief Marshal Sir Keith Park is life vice-president and the Chief of the Air Staff (Marshal of the R.A.F. Sir Dermot Boyle) and A.O.C-in-C. Fighter Command (Air Chief Marshal Sir Thomas Pike) are *ex-officio* vice-presidents.

The objects of the Association are to look after the welfare of members and their dependents, in co-operation with the R.A.F. Benevolent Fund and other charitable organizations; to preserve the memory of fighter aircrew who died in the Battle of Britain; to foster good fellowship amongst members in perpetuation of their wartime comradeship; and to perform functions and ceremonies in furtherance of the objects of the Association.

It is intended that the Association shall meet on September 15 each year to recall the events of the summer and autumn of 1940 and to pay tribute to Lord Dowding.

SILENT SPORT: Balloons from several nations are seen, on July 13, before the start of a race from Düsseldorf. Shortly after the picture was taken the Swiss balloon "Zirkus Knie" was forced to retire with a hole in the skin after a collision with the German balloon "Schwaben."

The Lords Debate the Industry

OPENING a 3½-hour debate on the aircraft industry in the House of Lords on July 16, Viscount De L'Isle, a former Air Minister, said he felt the industry was in for a lean period. Manufacturers would be occupied not so much with maintaining the pace of technological advance as in the grim task of economic survival. He feared for the air power of this country and for the wider effects on industry at large. Of all our main industries the demand for ploughing back money was most insistent in that of aircraft. Sums of 20 to 30 per cent of turnover were necessary if we wished to keep a leading place in the aeronautical field.

Exceedingly rapid developments had hitherto been met, in effect, out of public moneys; overheads for the contractors of civil aircraft had largely been met out of contracts for military aircraft. Both the U.S. and Russia were going ahead with the development of supersonic aircraft; but since the publication of the 1957 *White Paper on Defence* the U.K. industry had been on notice that it could expect no further help from the most advanced developments of military aircraft for the R.A.F. That left only the possibility of further aircraft for Coastal Command; possibly a further ground attack and/or reconnaissance type; and large transports. If the R.A.F. was unable to issue more operational requirements for advanced conceptions, where could great firms look? Not—in view of the fate of the SR.177—to the export market.

There was left the transport field. How was the industry to compete with the U.S., which would have a "lead in" of at least one type of supersonic bomber? If the Government thought we could produce a supersonic transport without that "lead in" let us hear so. How much better if a development of the Comet had gone into service with R.A.F. Transport Command to have "the bugs flown out of it." Could research and development costs of engines for a subsonic airliner be recovered over a small domestic market? We had some of the best engine manufacturers in the world. But these advantages would pass. He would like to know what was being done about a ground attack fighter with a short take-off and supersonic performance. Was NATO looking to us—or elsewhere? Did the Government still consider there was no foreseeable need for a further development of a manned supersonic fighter? Did it consider it was still possible to sell abroad types of aircraft for which there were no domestic orders? That there was a need for a ground attack and/or reconnaissance aircraft for the R.A.F.? That it would be possible to develop a supersonic civil airliner without first a supersonic bomber or tanker for the R.A.F.? That it would be economically possible to recover the research and development cost of any large civil aircraft for which a certain market is limited to the R.A.F. and one or both Corporations? What steps had been taken to co-ordinate the industry with those of the leading NATO powers?

Real Prospects

LORD OGMORE said that at present the aircraft industry was to a large extent rudderless; it was getting no lead from anyone. The Government saw its rôle as providing for total war needs by the manufacture of ballistic missiles; he agreed with Viscount De L'Isle that it was underestimating the position of the industry and the needs of defence.

LORD BRABAZON said the industry should be aided because of its export value in material and prestige terms. Though we had in the Britannia the best aircraft crossing the Atlantic, the great American jets were coming in soon. He thought the Government could help the industry more than by the oft-repeated plea that Transport Command should fit itself with the most up-to-date machines in large quantities.

VISCOUNT KNOLLYS said the true position and prospects of the British aircraft industry were not yet fully realized, because it looked so prosperous at present; but the real prospects could be very grim unless certain facts were realized and some constructive support provided by the Government. The Minister of Supply has said that numbers employed would fall from 250,000 to 150,000; but it was not always realized that numbers would fall below that unless aircraft firms were given some help. He suggested several reasons for "this uncomfortable position"—the growing difficulty of selling transport aircraft in an increasingly competitive world market, which might soon include Russia; the strained position of airlines all over the world; the demand for long credits and even for the trading-in of secondhand aircraft; finally, the enormous cost of development, which was the main worry of aircraft constructors. He gave figures for the Vanguard, saying that Vickers had already provided £4m for development and tooling alone—and that was only part of the total cost of development. If this was the case for a medium-large aircraft, what was it going to be for transatlantic and supersonic types of the future? Companies also had to provide against commercial risks; and their ventures were "not without benefit to the country." Vickers had at present two private ventures entirely financed by their own money—but unless some aid were available, they might be the last of this kind the company could undertake.

He suggested that a limited amount of Government financial help for development costs, to be recovered from a royalty on sales (firm orders for Transport Command would put the industry in a position to "go ahead at home" on its own, and they should be placed on the same basis as those for B.O.A.C. and B.E.A., when the customers were satisfied that the aircraft to be developed and produced met their needs). Secondly, long-term credit—which could be provided by the Export Credits Guarantee Dept.

THE EARL OF SWINTON said that one of the most agreeable features of this debate was that there were absolutely no politics in it. "Here you have men of wide experience, administrators, manufacturers and scientists, merely determined to see what is the wisest policy for this industry."

LORD KINDERSLEY, referring to the aero-engine industry, spoke of the time it took to develop an engine and the cost of that development. Five years was the minimum development period, though it had been known to take ten; costs were anything from £15m to £20m, or even more. The £40½m of engines in the £116m of exports mentioned by Lord Brabazon were the products of a decade of development when the industry was enjoying the full support of Government defence expenditure. Those days have changed and the industry had been put on notice that it must stand on its own feet for future development of engines for commercial aircraft.

LORD ADRIAN said the aircraft industry was in the front line of our technological advance; if we weakened it severely we would endanger our position as a nation.

LORD WEEKS said he considered a certain amount of amalgamation or grouping was desirable in the industry; only one agency could stimulate the reorientation of an industry—the Government.

LORD SHEPHERD said we had heard little from the interdepartmental inquiry into the industry. The Government was wrong to put it into the same group as manufacturers who produce for the general consuming industry.

VISCOUNT CALDECOTE said that over the last ten years the Ministry of Supply had spent some £600m on research and development for the aircraft industry—about one-tenth of it on work for civil aircraft. During a similar period, exports had amounted to about £650m and they were now running at about £150m a year. Could the Government's money have been better spent? He was very doubtful if it could.

LORD SEMPILL suggested that the Government should set up an entirely independent air tribunal, as proposed by Lord Ogmore.

LORD MERRIVALE asked whether the Government's technical information on the Fairey Rotodyne was sufficient, or whether withdrawal of support was a case of a Treasury decision conflicting with a technical requirement.

Partnership Envisaged

LORD MANCROFT, summing up, said he wished to put the debate into the perspective of the *White Paper on Defence* of 1957 and spoke of the post-war contraction of the industry and its expansion during the Korean War. The Government did not underrate the industry's importance. He felt that the Working Party of senior officials was doing a good job in finding out about the industry. As a result, it had been decided, in addition to sponsoring aeronautical development to meet defence requirements, to contribute financially to aeronautical research in the expanding field of air transport. What the Government was doing was to underwrite the future of the industry by continuing to support the basic research necessary for its survival. In the long term the industry must stand on its own feet, but it would be too much to ask of it, at this critical stage in its development, to carry the full cost of aeronautical research. For the next generation of civil aircraft, the Government would be prepared to consider on their merits individual cases for financial help. What was envisaged was a partnership between State and industry, the one financing basic research and the other aircraft development and production. As the industry's financial strength grew, so would the Government look to it to shoulder more of the cost of civil research. But the large number of companies was not the most effective organization to compete effectively in world markets; it was the Government's policy to encourage greater integration, though "shotgun weddings" were the last thing it desired.

In discussions with the industry, future requirements had—so far as possible—been made known. With such knowledge, the industry should be able to organize itself in such a manner as to make the best use of the great capital investment which had been made in it. Overseas competition was formidable, but so was the partnership. There was a growing commercial association between the U.K. and European industries; we did not neglect any opportunity of bringing our military aircraft to the notice of our Allies. It was difficult to sell abroad military aircraft which did not bear the *cachet* of an order from the R.A.F. or the R.N.; and the fewer types ordered for the Services, the less would be our export business in military aircraft. It would be indefensible to develop and order aircraft not required in the present strategic design, merely to maintain our export trade. There were two examples of overseas sales made despite the lack of a Service order—the Folland Gnat and Bristol Orpheus. The Government had done all it could to bring the merits of the SR.177 before the German authorities.

Supersonic Transports

Military orders in this country on the American scale were quite impossible; the only alternative was a Government contribution to development costs. It was unlikely that an order from the Corporations or by R.A.F. Transport Command would, of itself, make development an economic proposition. It was one of the principal tasks of the Transport Aircraft Requirements Committee to integrate home demand, both in time and type, and this might go some way to produce orders for the numbers required to reach the "break even" point. It was true that some of the work which would have been done on the now-cancelled supersonic bomber would have helped in designing our first supersonic transport; but no one would be so rash as to propose we should develop the bomber merely for the sake of the transport. Cancellation of the bomber did not affect the Government's determination to press on with the studies it had launched for a supersonic transport. No decision had yet been reached on a Canberra replacement.

Of the Rotodyne, Lord Mancroft said the cost of development had so far largely been met by the Exchequer; but in accordance with the policy recently announced by the Minister of Supply, the companies concerned in the project had now been asked to show their commercial faith in it by putting up a substantial part of the money required to complete its development. As to Commonwealth co-operation, a conference of Commonwealth operators had been convened in London for next September. The suggestion that Transport Command should be used to help to "remove the bugs" from civil transports was being carefully considered. The Government had every confidence in this "great and exciting industry."

CIVIL AVIATION

RA.29's 1,000-HOUR OVERHAUL LIFE

FROM Rolls-Royce last week came this statement concerning progress with the civil Avon turbojet. In its way it makes air transport history:—

"The Air Registration Board of Great Britain has authorized a life of 1,000 hours between overhauls for the Rolls-Royce Avon RA.29 of 10,500 lb thrust, power unit of the de Havilland Comet 4 and the Sud Aviation Caravelle. (This will be confirmed in the case of the first operator—British Overseas Airways Corporation—by an examination of two engines at 800 hours and two at 900 hours flying time.)

"A target of a 500-hour overhaul life was set when British Overseas Airways Corporation began an intensive engine proving exercise in September 1957. Two Comet 2E aircraft, powered by two RA.29s and two earlier Avons, made daily scheduled flights from London to Beirut and back at an aircraft utilization of eleven hours per day, accumulating 7,000 hours of flying time on the RA.29 engines. Only one RA.29 had to be removed prematurely, due to the failure of an ancillary unit.

"Engines were stripped and examined by the Air Registration Board at 250, 500, 750 and 1,000 hour lives. The excellent condition of the two 1,000-hour engines enabled the Board to authorize entry into service of the RA.29 at a 1,000-hour life—exactly double the target set last September."

Further details of this important advance will be given in next week's issue.

VISCOUNTS FOR NORTHEAST

ON July 16, the tenth anniversary of the Viscount's first flight, confirmed sales of the aircraft rose to 399. On that date Northeast Airlines of Boston, U.S.A., announced a firm order for nine 745D (ex-Capital) aircraft, with an option on a tenth.

Delivery of these Viscounts will be quick, since Northeast will take them straight off the shelf on which they have lain since Capital cancelled their repeat-order for 15 aircraft fourteen months ago. The first aircraft will arrive in Boston in a week or two's time, and two more will be delivered before the end of August. Services will begin in August on Northeast's routes through Boston, New York, Philadelphia, Washington and Montreal; services to the tourist areas of the south and to Miami via Jacksonville and Tampa will begin in the autumn.

Northeast's order, which was no surprise (*Flight*, June 27), means that at last Vickers have sold the bulk of the 15 aircraft which have been on their hands for so long. They could certainly have sold these 745Ds piecemeal without much trouble; but for a long time they hoped to sell all 15 (plus seven more) to T.W.A. Mr. Howard Hughes, who is a major T.W.A. shareholder, for a long time appeared to be seriously interested in the purchase of these Viscounts, and T.W.A. actually undertook the conversion of crews and ordered the carrying out of modifications.

Of the original 15 ex-Capital 745Ds, ten are now thus accounted for by Northeast; two others have already been sold (one to the Canadian Government, the other to Capital) and three are on charter (one to T.A.A., two to B.E.A.). Northeast's Viscount investment, with spares, amounts to £5.35 million. This puts the cost of each 745D, assuming a generous 30 per cent allowance for spares, at around £420,000 each.

A puzzling aspect of the order is that Northeast—having recently cancelled their order for five Bristol Britannia 305s costing, with spares, £6.25 millions because of inability to obtain satisfactory financing—are now raising £5.35 millions for a fleet of Viscounts (nine of which, incidentally, represent about the same traffic capacity as five Britannias).

At all events a third major U.S. domestic airline is to be a Viscount operator; and of particular importance to Mr. George E. Gardner, Northeast's chairman, is the fact that his airline will have appealing equipment with which to compete against Eastern Air Lines' Lockheed Electras when these aircraft are introduced on to the competitive holiday route to Florida this autumn.

Northeast are the fortieth airline to buy Viscounts, 328 of which have now been delivered.

The 1958 awards for meritorious weather reporting were presented at G.A.P.A.N. headquarters, Londonderry House, on July 15, by the director of services of the meteorological office, Dr. J. M. Stagg (right). Recipients were Capt. R. H. Rose (B.E.A.) and Mrs. W. J. Wakelin, on behalf of her husband, Capt. W. J. Wakelin (B.E.A.). Second from the left is Sir Frederick Tymms, Master of the Guild.

"Flight" photograph

PANAM'S TRANSATLANTIC JET PLANS . . .

ALTHOUGH reports and rumours have been rife, no official announcement has until now come from PanAm about their transatlantic Boeing 707 plans. Last week, however, the American airline stated that plans are now in hand to put the 707 into daily service between New York and London "this autumn." Scheduled time eastbound would be 6½ hours; six Boeing 707 120s will be delivered before the end of this year.

PanAm announces also that, starting on August 15, Boeing 707s will be operated between New York and San Juan, Puerto Rico, on a cargo and mail service, permission having been received from the C.A.B. thus to operate a provisionally certificated 707. Permission has also, say PanAm, been obtained from the Port of New York Authority to use Idlewild Airport for these services. This latter news is of particular interest in view of the P.N.Y.A.'s policy with regard to jet noise, which hitherto has excluded the 707's use of any New York airport. Presumably the permission given to PanAm for operations to Puerto Rico is provisional.

. . . AND DECTRA EVALUATION

JUST issued by PanAm's Atlantic Division is a report about their trials of Decca/Dectra across the North Atlantic.

"During the months of February, March and April of this year [says the report], the Atlantic Division of P.A.A. conducted an evaluation of the Dectra long-range navigation system aboard the Boeing Stratocruiser N1036V. This type of aircraft was chosen because a high percentage of its operating time is spent on the routes covered by Dectra. During the evaluation a total of 27 Atlantic crossings were made, all accompanied by an observer trained in Decca/Dectra operation. The total flight hours were 435.

"Within the area of Dectra fixing cover, it was found to be reliable, highly accurate, simple to operate and provided a new concept in the presentation of navigational fixing through the flight log (automatic pen recording of the position). The accuracy of Dectra was found superior to the standard navigational systems against which it was checked. The system was found to be almost unaffected by precipitation static and continued to function when all other radio reception was swamped out. Once the indicators and chart had been set up, operation was completely automatic except for mid-ocean adjustment, requiring less than a minute. Daytime coverage extended from Newfoundland to Ireland and from the Azores to Iceland, while night coverage was substantially greater. The principal disadvantage of Dectra is the lack of fixing cover west of Newfoundland. This could be remedied by the installation of a ranging station on the Atlantic coast of the United States.

BREVITIES

A FOURTH Britannia 313 has been delivered to El Al for service between Tel Aviv and New York. El Al's transatlantic frequency will be increased to seven a week on August 24.

* * *

The second prototype Caravelle is to be demonstrated at London Airport on July 29 and 30. A new order has been placed for one aircraft by Royal Air Maroc.

* * *

Offered for sale by W. S. Shackleton, Ltd., are the first Viscounts ever to come on to the second-hand market; they are two Type 747s originally operated by Butler and then by Ansett.

* * *

International Aeradio are to supply to the Civil Aviation Board of Hungary ground I.L.S. equipment manufactured by Pye and to Malev airborne I.L.S. manufactured by Standard Telephones and Cables.

* * *

Main cabin lighting in the Vanguard will be by fluorescent tubes operated at low voltage from a G.E.C. transistor oscillator inverter unit. This development by G.E.C. enables this type of lighting to be used inside aircraft for the first time.

* * *

Aquila Airways have now officially confirmed that they are to cease operations on October 1. "Abnormal swell conditions" have been experienced at Madeira for several seasons and have made services "uneconomic and unsatisfactory." The airline's three Solents are to be sold, probably to a Portuguese airline.

ROLLS-ROYCE

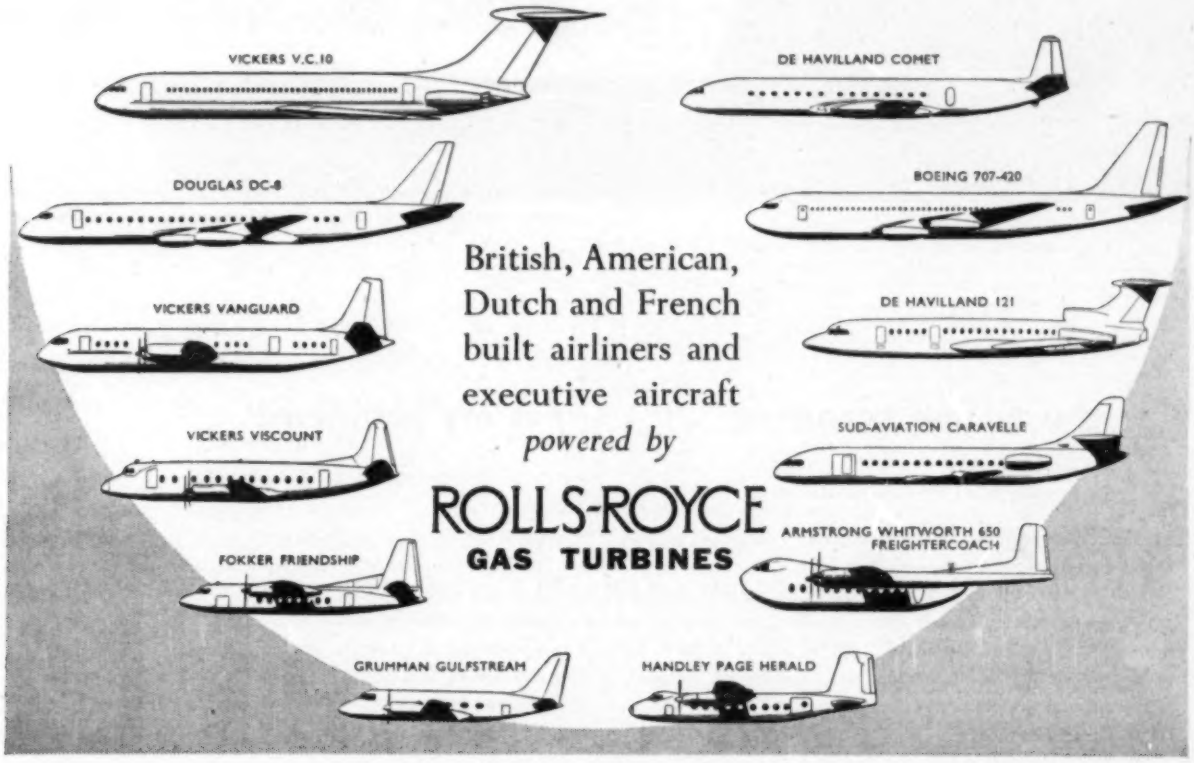
PROP-JET OR TURBO JET ENGINES

have been chosen by

OVER 50 AIRLINES

For their short, medium or long range airliners

Designed to give maximum performance and long life between overhauls, Rolls-Royce prop-jets and turbo jets are backed by the unique experience gained in over 4,000,000 hours airline operation of Dart prop-jets powering Vickers Viscounts on the air routes of six continents. More than half the prop-jet and turbo jet airliners in service with, or on order for, world airlines are powered by Rolls-Royce engines.



ROLLS-ROYCE LIMITED, DERBY, ENGLAND.

AERO ENGINES · MOTOR CARS · DIESEL AND PETROL ENGINES · ROCKET MOTORS · NUCLEAR PROPULSION

'Enough of left-handed tractor rotation . . .

the airline turnover is *my* problem!'

Profitable operation is uppermost in an operator's mind when considering new aircraft.

For an outlay 50% less than any other 4-engined turbo-prop, the Vickers Viscount 810/840 offers medium-haul operators the finest available combination of fast air transport, background experience, passenger appeal and profitable operation.

Air mile costs are as low as those of earlier Viscounts, but since the 810/840 has a larger capacity, seat mile costs are lower. The new Viscount 810 already has a cruising speed of 365 m.p.h. With the more powerful Rolls-Royce engines available in 1960, the aircraft will become the V840 with speed raised to 400 m.p.h.

The success of Viscounts is based on two important facts. Passengers prefer them – and they produce healthy airline balance sheets!

VICKERS VISCOUNT 810/840

FOUR ROLLS-ROYCE DART PROPELLER-TURBINE ENGINES

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

GA AT 573 A

Commercial Aircraft of the World

A "FLIGHT" COMPILATION

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Caravelle

Sud-Aviation: Société Nationale de Constructions Aéronautiques, Paris.

THE Caravelle is among the select band of transports that, by anticipating an airline need, promise to achieve commercial success before they enter service. Although it will be spring next year before the first Caravelles are flying on Air France's routes to London and North Africa, orders have already been placed by five airlines and, in the case of S.A.S., the original firm order for six has been doubled. First of the European short-haul jets (the decision to build the Caravelle was taken in 1952), the aircraft has established, in concept and configuration, a pattern for this class of airliner; and the advantages conferred by rear-mounted engines include an interior quietness that sets a new high standard for passengers' accommodation.

The first prototype aircraft flew on May 27, 1955, and the second prototype just under a year later, on May 6, 1956. The first production aircraft, destined for Air France, flew on May 18 this year. Two other partially complete airframes have been produced, one for a simulated 30,000 hr water tank fatigue test and another for resonance and static strength tests. The present production programme is based on a five per month rate early in 1960 but could be raised to 7 or 8 a month if needed. Sud-Aviation stated recently that 110 items of equipment are manufactured by British companies. The foremost of these is Rolls-Royce, who supply the Avon RA.29 engines, and other suppliers include Dunlop, Flight Refuelling, Graviner, Hobson, Automotive Products, Teddington Aircraft Controls, Venner and SPE.

COMMERCIAL HISTORY The first order for Caravelles was placed by **Air France** in February 1956, 12 aircraft being ordered and an option being placed on a further 12. The first delivery will take place later this year and the entire fleet should be in operation late in 1960. Air France has already accumulated considerable proving experience with the second prototype, which they received in June 1956 for route trials and for scheduled freighting over their European and North African networks.

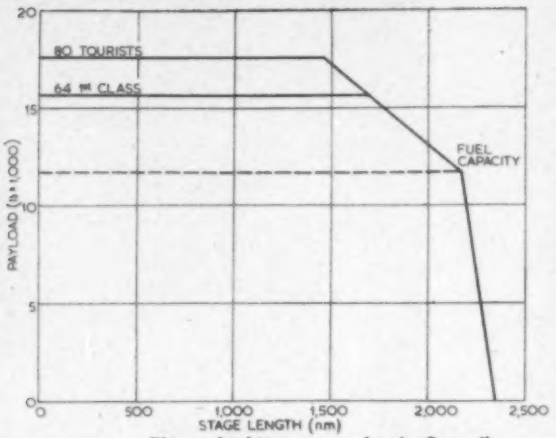
For over a year after the Air France order no further sales were effected. Then in June 1957 **S.A.S.** ordered six for delivery in 1959 and optioned a further 19 (six of these have since become firm orders). The following October saw **Varig** order two with options on a further three, delivery to take place in 1959. This year has seen three more carriers place firm orders for delivery in 1960; **Aero O/Y (Finnair)** ordered three in January; **Air Algerie** ordered three in March; and, most recently, **Royal Air Maroc** signed for two Caravelles in May. **Sabena** has also been mentioned as a likely Caravelle customer.

STRUCTURE **Fuselage** The fuselage is of conventional multi-stringer monocoque construction with circular frames. A cylindrical section, 126in diameter and 53ft long—nearly half the total fuselage length—forms the bulk of the pressurized total volume of 6,120 cu ft. This includes three baggage and freight holds: an upper rear compartment with a volume of 200 cu ft, an under-floor front hold with a volume of 200 cu ft and an aft hold with a volume of 90 cu ft. The cantilevered engine nacelles are carried from two heavy frames in the rear fuselage and the surrounding area is stiffened with robust frames and pierced vertical and horizontal webs. The fuselage contains 32 windows of curvilinear shape, four of which are inward-opening escape hatches. Two passenger entrances are provided, one by a door 30in × 72in fitted with a downward-opening stairway in the rear fuselage (which also serves as a tail support), and another one in front where there is a sliding door 36 × 67in on the port side. The floor is stressed to 120 lb/sq ft.

Wing Structural basis of the wing, the clean shape of which is unbroken by nacelles or pylons, is a three-spar torsion box forming an integral fuel tank. There is thus one redundant member as a safeguard against a fatigue failure. Top and bottom wing skins are taper-rolled and the torsion box is stiffened with spanwise stringers, quarter-crescent-shaped ribs and pierced baffle-ribs. The N.A.C.A. 651212 section wing originally included a variable camber leading edge, but with no appreciable decrease in performance this has now been discontinued in favour of a fixed member.

Undercarriage Responsibility for the undercarriage has been taken by Hispano-Suiza, who supply the four-wheel bogie main gear spaced on a 17ft track, and the nose gear, which is steered hydraulically through an included angle of 100 deg. The wheelbase is 38ft 7in. Dunlop manufacture the wheels, the Maxaret anti-skid brakes and the tyres, which are inflated to 124 lb/sq in.

POWERPLANT The Rolls-Royce Avon RA.29 engines of 11,700 lb thrust are more powerful than those with which Comet 4s will be equipped. Each engine is attached to two cantilever beams by means of connecting links at the front and by two trun-



This payload/range curve for the Caravelle is drawn for Rolls-Royce Avons at 11,000 lb thrust. Full assumptions are not stated by the manufacturers.

Caravelle . . .

nions at the rear. Longitudinal and transverse stainless-steel and titanium firewalls are incorporated within the nacelles. Hydraulic pumps and generators are mounted on an auxiliary gearbox underneath the engine.

SYSTEMS **Fuel System** Total capacity of the main and outer integral fuel tanks is 4,100 Imp. gal; a cross-feed system enables either engine to be coupled to any tank. Each tank is equipped with three capacitance-type fuel gauges and two electric pumps, and all four tanks can be pressure-refuelled from a single point under the wing in less than 15 minutes.

Flying Controls Automotive Products Servodyne irreversible hydraulic servos, the valves of which are operated through cables from duplicated wheels and pedals in the cockpit, power all flying control surfaces. Proportional feel is supplied artificially by a Hobson hydraulic feel simulator and loading jacks, and an additional bass feel is supplied by pre-loaded torsion bars. A Lear autopilot is standard equipment.

Cabin Air Pressure air is bled from the compressors of the Avon RA.29s, passed through a heat exchanger (ram air cooling scoops for which are located at the base of the fin) an expansion turbine and drier, and into the cabin. The maximum cabin differential pressure is 8.25 lb/sq in (8,000ft at 40,000ft).

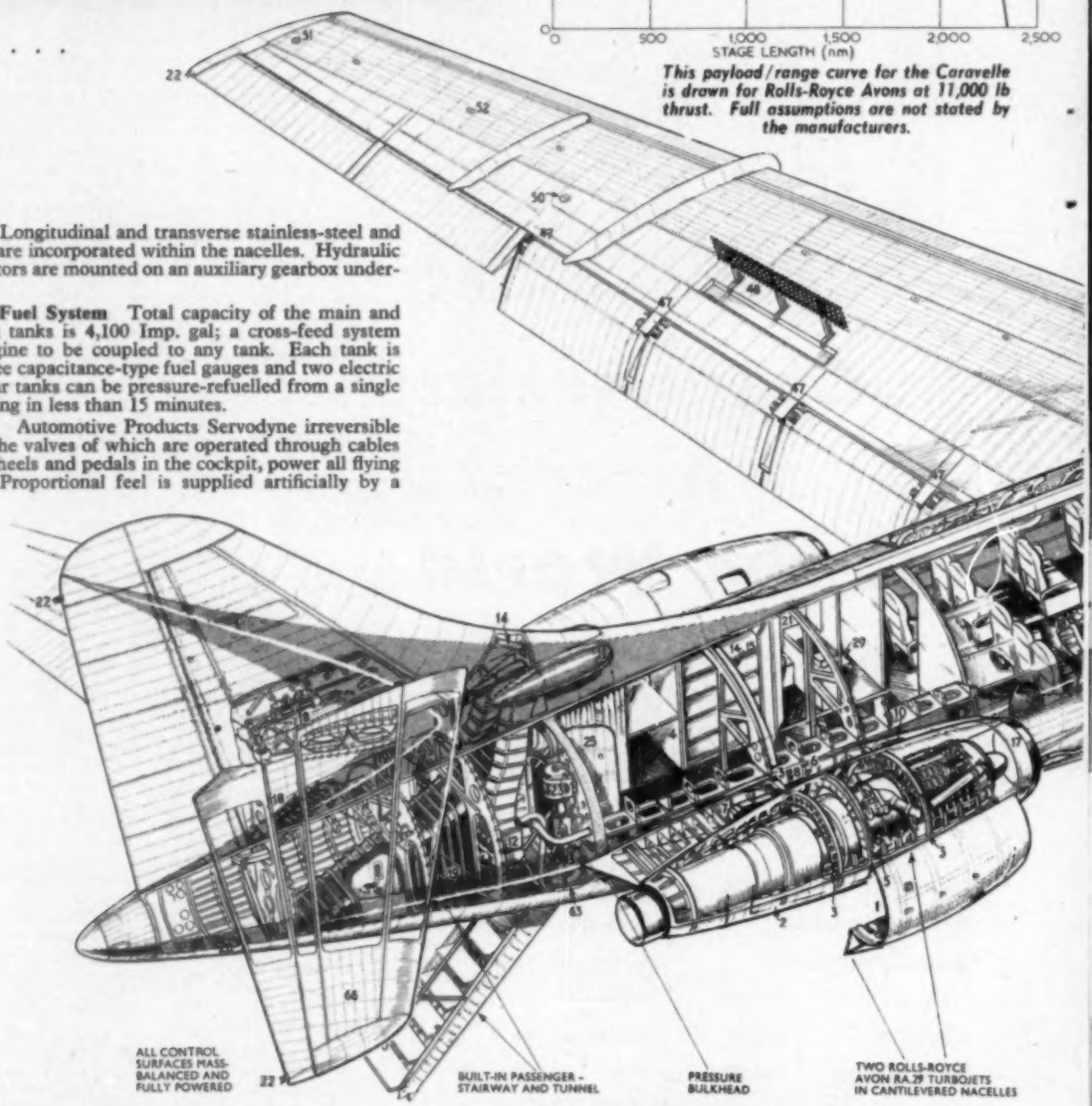
Ice Protection Tapped compressor-bleed air is also used for thermal de-icing of wings, tail unit and engine air intakes. The windscreen is electrically de-iced and defogged and pitot heads are protected electrically.

Hydraulics Two separate systems continuously in operation are provided for the hydraulic flying controls, undercarriage, flaps, wheel brakes, airbrakes, nosewheel steering and passenger steps. There is a further standby system for each of these circuits, so that supplies are duplicated and triplicated for the flying controls.

Electrics There are three primary circuits: a 28.5V DC system; a 26V 400 c/s AC system and a 115V c/s AC system. Power is supplied from a 30V DC generator on each engine and all 115V AC current is supplied from a pair of inverters.

Radio and Radar Standard equipment includes an H.F. transmitter-receiver, two V.H.F., two radio compasses, two V.O.R. receivers, two glide slope receivers and one marker beacon receiver, usually supplied by Collins.

PAYLOAD ACCOMMODATION Standard Tourist seating is 80 seats, five abreast with a central aisle at a 37in pitch but an alternative layout is for 64 first-class seats, all of which are mounted on tracks spaced at 31.7in for quick adjustment. The total cabin volume is 2,825 cu ft.


ALL CONTROL SURFACES MASS-BALANCED AND FULLY POWERED
BUILT-IN PASSENGER-STAIRWAY AND TUNNEL
PRESSURE BULKHEAD
TWO ROLLS-ROYCE AVON RA.29 TURBOJETS IN CANTILEVERED NACELLES

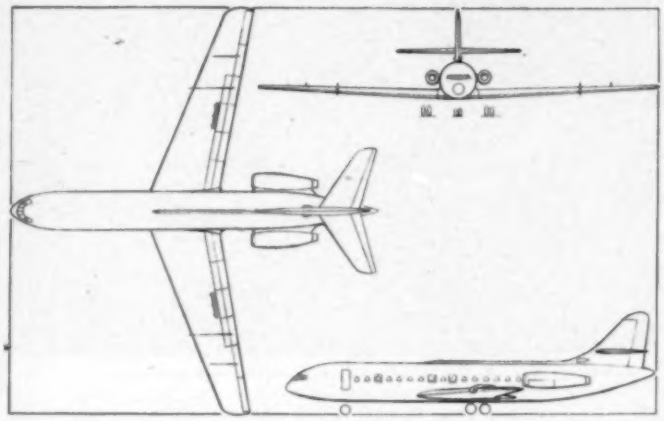
S.E. 210 CARAVELLE

Two Rolls-Royce Avon RA.29s of 11,700 lb static thrust

Dimensions: Span, 112ft 6.4in; length, 105ft; height, 28ft 7in; gross wing area, 1,579 sq ft; sweep angle, 20 deg at quarter-chord; flap area, 266 sq ft; undercarriage track, 17ft; wheelbase, 38ft 8in; fuselage outside diameter, 126in; total pressurized volume, 6,120 cu ft; total cargo volume, 490 cu ft.

Weights: Maximum take-off weight, 97,000 lb; max. landing weight, 92,600 lb; operating weight empty, 56,230 lb; zero fuel weight, 77,160 lb; capacity payload, 18,250 lb.

Performances: Take-off field length (97,000 lb gross weight, sea level, I.S.A.), 5,600ft; landing run (C.A.R. 4b ruling), 3,000ft; typical cruising speed at 82,000 lb and 28,000ft, 515 m.p.h.; cruising altitude, 20,000ft to 40,000ft; payload range performance, see graph.



1 Hinged lower cowling
2 Removable lower cowling (upper sections fixed)
3 Engine suspension frames
4 Hold, with racks for hand luggage
5 Transverse firewall
6 Longitudinal firewall (end rib of pylon)
7 Generator
8 Hydraulic pumps
9 Main fuel supply pipe
10 Fuel heater
11 Intakes to air-conditioning heat exchanger
12 Air-conditioning heat exchanger
13 Stairway operating-jack
14 Fin de-icing air
15 Tailplane de-icing air
16 Wing de-icing air
17 De-icing air around engine intakes
18 Powered-control Servodyne units
19 Control cables
20 Manhole
21 Toilet, port and starboard

FORWARD-RETRACTING NOSEWHEELS

THREE-SPAR TORSION BOX FORMS INTEGRAL FUEL TANK OUTBOARD OF FUSELAGE. TOTAL CAPACITY 18,000 litres (4,100 Imp gal)

INNER-WING FUEL TANK

OUTER-WING FUEL TANK

HISPANO BOGIE-TYPE MAIN UNDERCARRIAGE, DUNLOP WHEELS AND BRAKES WITH MAXARET. DIMPLED TYRES

CONSTANT-CHORD SLOTTED FLAPS. FOUR SECTIONS EACH SIDE. MAXIMUM DEFLECTION 35 deg

22 Zero-length static dischargers
23 Hydraulic reservoir (blue system), green to port
24 Hydraulic reservoir (red system)
25 Passenger door in pressure bulkhead
26 Four emergency windows
27 Emergency exit/service door
28 Fuselage centre caisson (pressure walls, undercarriage bay)
29 Stewardess seat
30 Main-undercarriage up-stop
31 Mainplane centre-line joint
32 Main spar anchorages
33 Door to forward under-floor freight hold
34 Wing icing inspection light
35 Passenger entrance
36 Nosewheel doors (closed until retraction begins)
37 Suppressed A.D.F. aerials
38 Radio racks port and starboard
39 Step down to flight deck
40 Contact-breaker panel
41 Comet-type seats and flying controls
42 Emergency hydraulic pump
43 D.M.E. aerial
44 Galley and pantry
45 Third crew-seat
46 Flap-jack drive shaft
47 Flap screw-jacks
48 Perforated air brakes and single jack
49 Automatic slot-covers
50 Inboard fuel-tank gravity filler
51 Outboard fuel-tank gravity filler
52 Fuel gauges (capacitance type, nine per wing)
53 Pressure refuelling valves (inner tank)
54 Pressure refuelling valves (outer tank)
55 Pressure refuelling control panel (hinges down)
56 Inspection panels (open)
57 Mass balances (elevator similar)
58 Lower half-ribs (tops not shown)
59 Extended stringers
60 Nosewheel steering wheel
61 Direct-vision panels
62 Mainwheel doors closed for ground clearance
63 Provision for fire-suppression bottles in this bay
64 Detachable wing tip
65 Nose radar
66 Spot-welded spanwise stringers; riveted ribs
67 False rear spar
68 Main undercarriage jack
69 Office and steward seat
70 Tank air-vent float valve
71 Nosewheel jack
72 Main frame/box-spar joints
73 Eighty passenger seats
74 Production break-joints

A. BOMBELE

Friendship

Royal Netherlands Aircraft Factories Fokker, Schiphol, Amsterdam
U.S. Licensees: Fairchild Engine and Airplane Corp., Hagerstown, Maryland

WITH the first flight of the first production aircraft now comfortably in the log-book and order books still steadily filling out, Fokker's F.27 Friendship is now well on the path to established commercial success. First in the field with the twin Rolls-Royce Dart branch-liner formula, the Friendship has so far been the undisputed choice of local service and feeder lines seeking to replace their DC-3s or C-46s with turbine equipment.

Just how sound a piece of business it was to appoint Fairchild as licensees in the United States (the agreement was concluded in April 1956) has been convincingly demonstrated during the past twelve months; orders for Fairchild-built F.27s, in particular from U.S. local service carriers and South American operators, have substantially exceeded the total on order with the Dutch company at Schiphol, which has virtually no home market to supply. Fairchild-produced aircraft differ from Dutch-built Friendships in several important respects. All Fairchild F.27s, for example, carry 1,100 Imp. gal fuel, built-in stairs, a radar nose and largely American accessories. Many Fairchild customers are likely to specify Dart RDa.7s.

Important dates in Friendship history are November 1955, when the prototype first flew; March 23, 1958, the first flight of the first production Friendship for Aer Lingus, eight days ahead of a schedule set 2½ years earlier; and October 29, 1957, when the

F.27 FRIENDSHIP

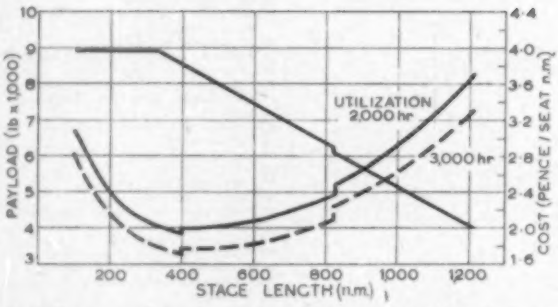
Two Rolls-Royce Dart 511 of 1,728 e.h.p., each driving Rotol four-bladed 12ft propellers*

Dimensions: Span, 95ft 2in; length, 75ft 9in; height, 27ft 6in; wing area, 754 sq ft; aspect ratio, 12; airfoil section, root, N.A.C.A. 64_1—421 (modified); tip, N.A.C.A. 64_2—415 (modified). Total cargo capacity available, 355 cu ft.

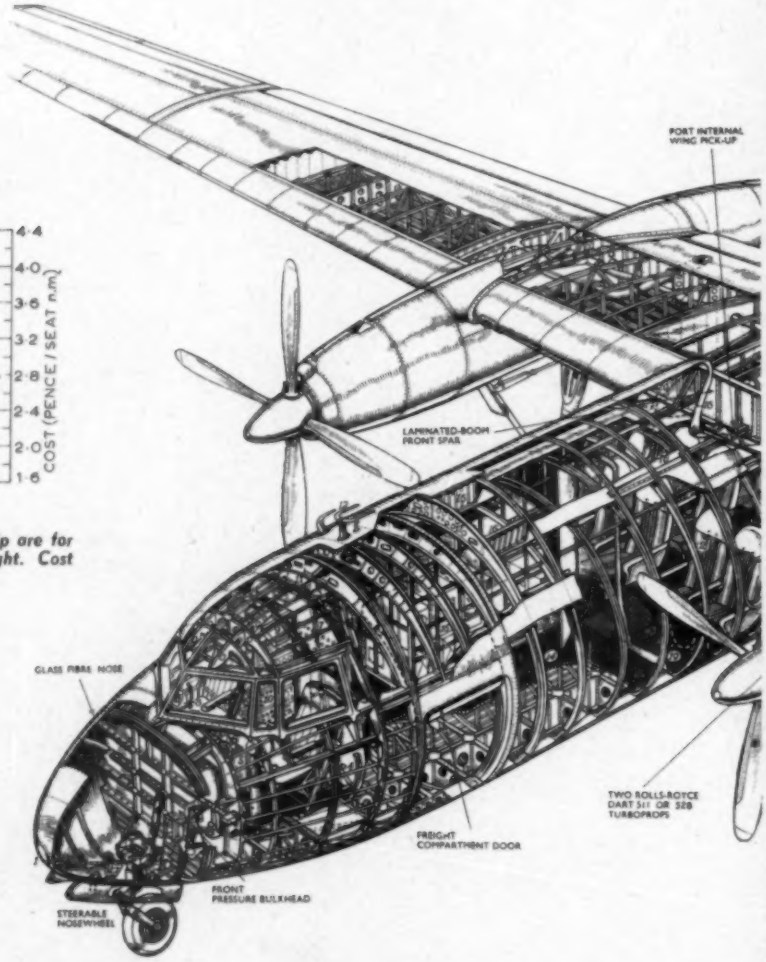
Weights: Maximum take-off, 35,700 lb; landing, 34,000 lb; zero fuel, 32,400 lb; basic operation (32 passenger seats), 21,649 lb; maximum payload (32 passengers, baggage and 3,462 lb freight), 10,278 lb.

Performance (at 33,000 lb in standard conditions): Cruise speed at 20,000ft and 13,600 r.p.m., 232 kt; rate of climb at sea level, 1,375ft/min; single engine gradient of climb at sea level, 3.5 per cent; service ceiling, 31,800ft; service ceiling (gradient of climb 1.4 per cent) on one engine, 10,000ft; take-off field length (35,700 lb, sea level, I.S.A.), 4,100ft; sea level landing field length at 34,000 lb, 3,240ft.

* An alternative version of similar gross weight but improved performance is offered with Dart 528s (1,990 e.h.p.).



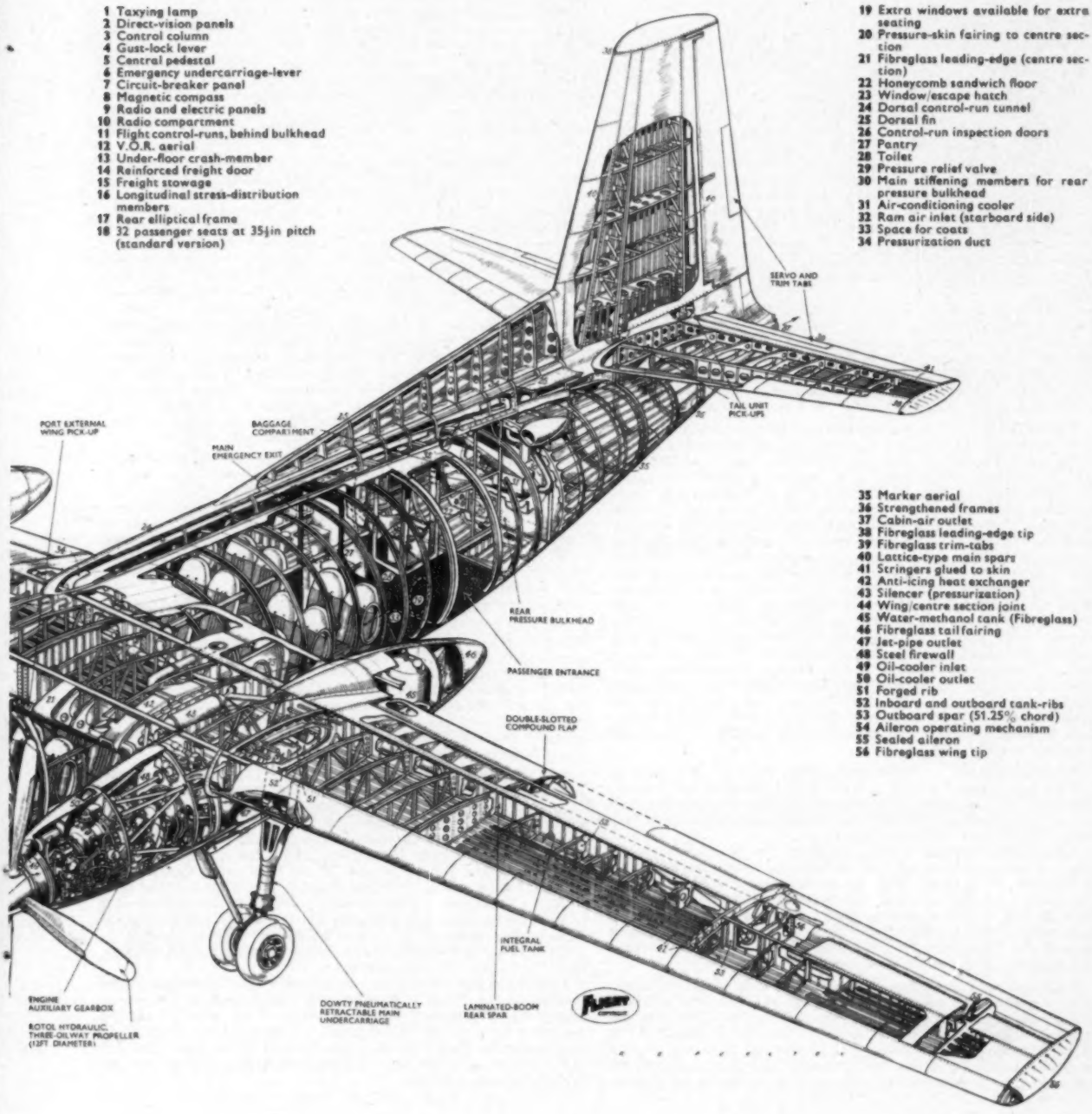
Payload range curves for the Dart RDa.6-powered Friendship are for I.S.A. conditions, 40 passengers, baggage and 410 lb freight. Cost curves are based on the S.B.A.C. formula.



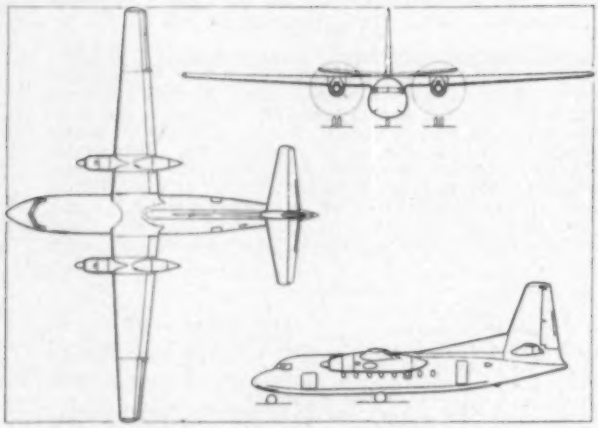
Friendship was certificated by the U.S. Civil Aeronautics Administration at a maximum gross weight of 35,700 lb. This last event was of great significance in the progress of the F.27, as the makers had to comply with both CAR 4b regulations and C.A.B. Special Civil Air Regulation No. SR422 (for turbine aircraft). To credit to Fokker must be added approbation of the considerable amount of British equipment with which the Friendship is equipped—Rolls-Royce engines, Rotol propellers, Dowty undercarriage, Godfrey cabin blowers, Rumbold seats and various items of ancillary equipment from other manufacturers.

Friendships are now beginning to roll from the production lines of Fokker at Schiphol and Dordrecht and Fairchild at Hagerstown. The first aircraft from the Hagerstown factory flew on April 15, and production deliveries began with the handing over of a Fairchild F.27 to West Coast Airlines on June 22. After an extensive test programme, the first production aircraft from Amsterdam should be delivered to Aer Lingus in October. Meanwhile, the Fokker sales effort continues; the second prototype was extensively demonstrated in India and the Middle East in December on a tour which included a landing on the 11,540ft Leh airstrip in the Himalayas. In late April a Friendship, equipped for the first time with pylon fuel tanks, left Schiphol for a sales tour in South America. It operated successfully into the 13,190ft airport at La Paz, Bolivia, and returned to Amsterdam on July 2.

COMMERCIAL HISTORY The Friendship is Fokker's first airliner for 20 years, and can trace its ancestry to the famous Fokker airliners of the 'thirties such as the Trimotor F-7, F-10, F-12 and F-18 which were the standard equipment of many airlines, and of K.L.M. in particular. Fokker undertook the market research which resulted in the Friendship in 1951. The decision to go ahead with the construction of a prototype was taken in the summer of 1952, and the first flight took place on November 24, 1955. By then the first order had been placed (two for **K.L.M.**), and in April 1956 the licence agreement with Fairchild—which had been the subject of negotiation for some time—was finally



Friendship . . .



concluded. Combined Fokker and Fairchild sales stand at a total (including unconfirmed orders) of 142, comprised as follows:—

Fokker-built: K.L.M., 2; **Aer Lingus,** 7 (late 1958); **T.A.A.,** 12 (1959); **Dutch Government,** 1; **R.I.V.** (Turin), 1; **Braathens,** 3; **D.C.A. Australia,** 2; **Iranian Oil,** 2; **Trabajos Aereos y Enlaces,** 3 (spring 1959); **Philippine Air Lines,** 2 (late 1959); **Sabena,** 12; **Belgian Air Force,** 6; **Aviaco,** 6 (1959); **Horten** (Germany), 1 (1960). The Belgian orders have not been confirmed, and there is some doubt as to whether K.L.M. and T.A.E. require delivery. However, including these orders, Fokker's sales number 60 aircraft.

Fairchild-built: West Coast, 6; **Mackey,** 4; **Bonanza,** 6; **Piedmont,** 8; **Quebecair,** 2; **Aerovias Ecuatorianas,** 1; **Pacific** (was Southwest), 6; **Northern Consolidated,** 5; **Whee'er** (Quebec), 4; **Avensa,** 5; **Wien Alaska,** 3; **L.A.V.,** 11; **Cubana,** 4; **L.A.B.,** 3; **Trans Mar de Cortes** (Mexico), 1. In addition to these 69 airline sales, 13 executive versions have been sold, bringing Fairchild's order book to 82. **Frontier's** order for 4 has been cancelled.

STRUCTURE A characteristic of the Friendship structure is the extensive use that has been made of Redux bonding, both in the attachment of the stringers to the skin and in the construction of laminated wing spars. The fuselage, pressurized to a dP of 4.16 lb/sq in (8,000ft at 20,000ft) is of semi-monocoque construction with longitudinal reinforcing beams in the lower section. The wing is built in five sections comprising detachable wing-tip sections, outer wing panels and a common centre section carrying the engine nacelles. The structure is similar throughout the wing and consists of front and rear spars forming a torsion box with spanwise stringers and wing skins. In the outer wing panels the skins are tapered and closing ribs form an integral fuel tank. Intermediate chordwise ribs act as tank baffles. Use of plastics extends to the wing-tips, glass fibre reinforced plastic skin trailing edges and metal honeycomb leading edges with reinforced plastic-faces. Tailplane and fin are of conventional construction, apart from the leading edges and tips which follow the techniques employed on the wing. The main undercarriage is a Dowty unit with twin 9.50×16in Dunlop tyres (inflated to 60 lb/sq in pressure) and Maxaret brakes. The nosewheel is steerable through an included angle of 120 deg.

POWERPLANT Rolls-Royce Dart RDa.6 Mark 511s of 1,720 e.h.p., or Dart RDa.7/1 Mark 528s developing 1,990 e.h.p., are fitted, driving 12ft diameter Rotol four-bladed constant speed, feathering propellers. To date, some eight customers of Fairchild-built aircraft have specified RDa.7s.

Each nacelle consists of three sections: the detachable power-plant, a centre section attached to the wing centre section and a detachable tail portion. Within the centre section are contained the main undercarriage and water/methanol tanks, and at the forward end is a fireproof bulkhead through which passes the outward-inclined shrouded jet pipe. A separate compartment behind the firewall contains the Rotol accessories gearbox, with the majority of the accessories mounted vertically.

Fuel System All fuel is contained in two integral wing tanks with a total usable capacity of 788 Imp. gal, but from the 37th aircraft onwards the capacity will be increased to 1,100 Imp. gal, and will bring Fokker-built aircraft into line with Fairchild F.27s. A cockpit-controlled cross-feed is employed. Inboard of each nacelle a welded stainless steel collector tank, connected to the main tank by two fuel lines, is provided to minimize the amount of unusable fuel at varying pitch angles. Refuelling is carried out through a filler in the top of each tank, but provision is made for underwing replenishment. Fokker have recently added supplementary fuel to the Friendship's capacity with large underwing pylons outboard of the nacelles containing 375 Imp. gal each.

SYSTEMS **Flying Controls** Dual wheel and pedal cockpit flying controls are fitted, and the surfaces are operated through tensioned control cables, those on the elevator being duplicated. A mechanical gust lock in the cockpit operating on all three surfaces permits sufficient throttle opening for taxying, but permits only one engine to be run-up at a time. Flaps, extending from fuselage to aileron, are of the Fokker single-slotted compound type and are operated electrically. An asymmetric flap warning light is provided on the control pedestal.

Cabin Air System Air is supplied at about 88 lb/min at sea level by two Godfrey cabin blowers, one driven from each engine. A Stratos freon system and heat exchanger are used in Fairchild F.27s. Cabin air instruments and controls are operated by the second pilot. Air enters through apertures under the luggage racks and a separate duct below the cockpit windows, and is discharged through slits near the floor. Nesa glass panels are provided in the cockpit. Located behind the rear pressure bulkhead is a turbine expansion cold air unit and an 8in connection to the cabin air system is provided for ground conditioning.

Ice Protection The standard de-icing system on the leading edges of the wing and tailplane is now inflatable Goodrich and Bendix rubber boots fed by bleed air sequenced by solenoid valves and an electric timer. The engine air intake, propeller and spinner, windscreen, accessory cooling air intake and pitot head are de-iced electrically.

Pneumatic System Dunlop four-stage compressors, one driven from each engine, supply air for the Friendship's all-pneumatic systems. Air stored in a 750 cu in bottle in the front cargo compartment is at a pressure of 3,300 lb/sq in and air at 1,000 lb/sq in is used to operate the undercarriage, nosewheel steering and brakes. An emergency circuit protects against failure of either main supply, and exhaust and shuttle valves permit emergency operation of each circuit. A separate storage bottle of 100 cu in capacity provides sufficient energy to operate the brakes if the normal pneumatic supply fails.

Radio and Radar A wide variety of equipment can be installed. Provision is made for Collins V.H.F. and H.F. sets, Collins glide-path and marker receiver, Bendix A.D.F. and intercom and Sperry remote indicating compass. Space provision is also made for Smiths S.E.P.2 or Collins AP-101 autopilots. Fairchild F.27s carry R.C.A. A.V.Q.10 weather radar in a metal nose section with a glassfibre nosecap, with a resulting increase in length of 16in. This design will also apply to later Fokker-built aircraft.

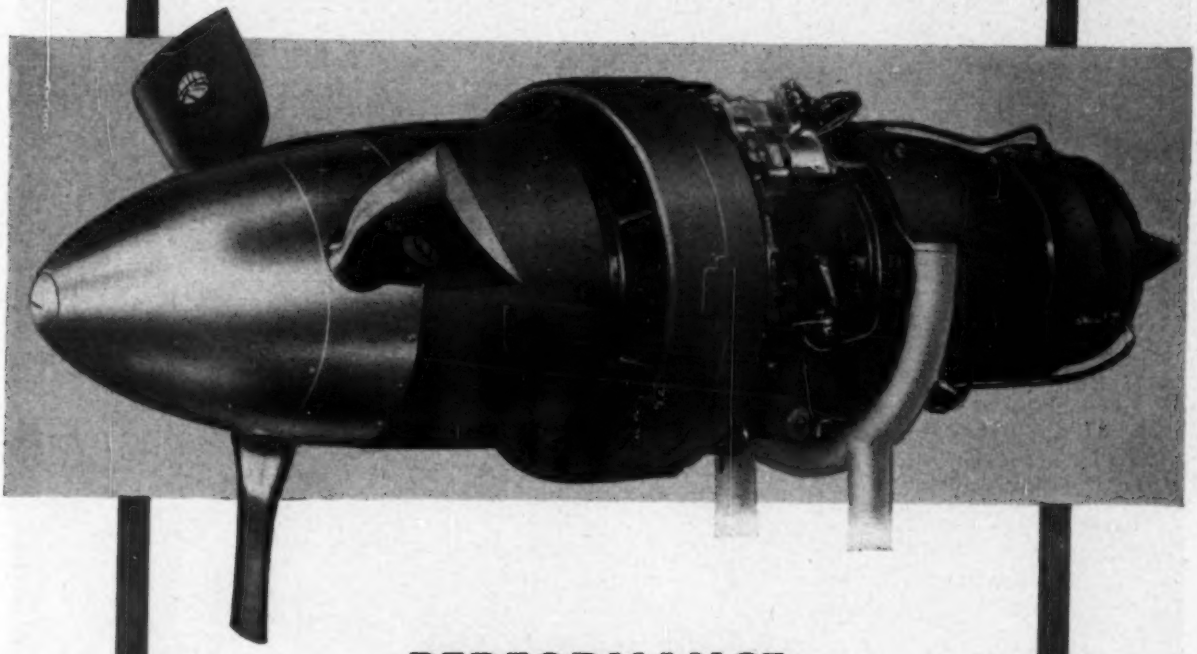
Electrical System The primary electrical system is a single-wire earthed circuit operating on 24 to 28 volts D.C., with a secondary 115V, 400 c/s three-phase constant frequency A.C. system and a single phase 26V, 400 c/s instrument supply. Separate 208 volt three-phase A.C. is supplied for de-icing. D.C. is supplied by an engine-driven generator on each engine charging a 24V battery, and A.C. by two 500 VA inverters with a smaller standby. An alternator on each engine provides variable-frequency A.C. supplies.

FLIGHT DECK Standard flight crew seating is for two pilots, with provision for supernumerary crew member if required. The F.27 can be safely flown by a pilot and flight engineer. The pilots' seats have folding armrests and are adjustable vertically and horizontally, and the bulkhead behind the pilots has a curtained opening with no doors. A central pedestal carries the throttle and fuel cocks, trimming wheels, flap switches, and push-button undercarriage selectors. Radio controls, engine starters, relight buttons and electrical switches are overhead, and conventional flight panels are placed in front of each pilot.

PAYLOAD ACCOMMODATION The standard seating arrangement is for 32 passengers in sixteen forward-facing double seats with fixed backs. A pantry and toilet are positioned on the starboard side aft of the passenger compartment opposite a curtained-off wardrobe. Alternative arrangements cater for 36 or 40 passengers at the same 35½in pitch; additional space is provided by reducing the volume of the 255 cu ft of cargo space in the forward fuselage to 77 cu ft and deleting pantry space at the rear. A 100 cu ft baggage compartment is provided in the extreme rear of the fuselage aft of the toilet. Freight that can be accommodated with 32 passengers (213 lb each) is 3,462 lb; with 36 passengers, 2,175 lb; and with 40 passengers, 720 lb. Figures for Friendships with Dart Mark 528s are similar.

Fokker are also offering an all-cargo and mixed passenger-cargo version of the Friendship called the Freightship, a Troopship, and a 10-16 passenger executive version. All versions can be equipped with either RDa.6 or RDa.7 engines; the Freightship incorporates a large forward cargo door, 91.5in by 70in, that will accommodate a Landrover. Maximum payload is 10,586 lb in the RDa.6-engined version.

BASTAN
TURBO-PROP ENGINE



PERFORMANCE

650 H.P. Specific Fuel Consumption = 0.73

600 H.P. (Maximum continuous) Specific Fuel Consumption = 0.74

Weight 585 lb. (including propeller)

BLACKBURN — TURBOMECA

BLACKBURN & GENERAL AIRCRAFT LIMITED

ENGINE DIVISION 43 BERKELEY SQUARE · LONDON · W.1

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To what far horizons?

He's at home in his small world. A house, a garden, a few streets, are the limits of his experience. But he's learning fast, and every day enlarges his horizon.

Like him, we are growing in experience; as the work of the International Geophysical Year goes forward, so does our knowledge of our home, the Earth. And with knowledge our achievement, too, will grow—to who can tell what far horizons?

To this end, the BP Aviation Service makes its own contribution by supplying fuel to the aircraft of today and by unceasing research for the fuels of the future.

AVIATION BP SERVICE

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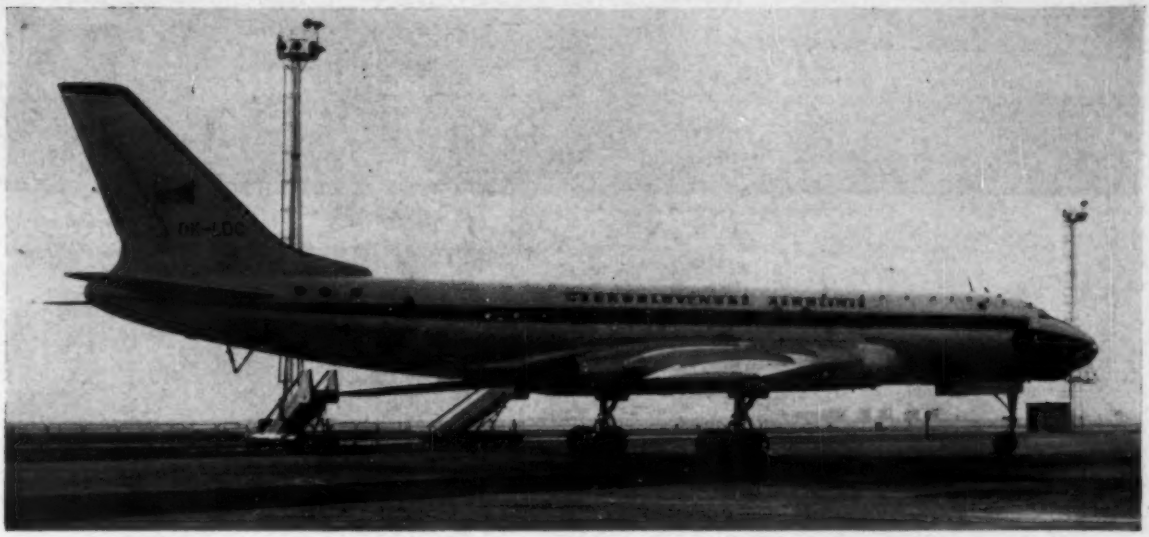
The international aircraft fuelling service of The British Petroleum Company Limited

IGY3



Above, Tu-104A. Below, interior of Tu-104A.

Tu-104A

THE principal difference between the Tu-104A (the standard production version) and its "prestige" precursor the Tu-104 is that it normally seats 70 passengers instead of 50. The two engines—Mikulin AM-3s (RD-3s) each delivering about 19,000 lb of thrust—are said to have a lower specific fuel consumption than those in the Tu-104.

Over 70 Tu-104s and 104As are now in Aeroflot service, and Tu-104As have also been exported to Czechoslovakia and other countries. Developed from the "Badger" bomber, for many years a standard type in the Soviet Air Force, the basic Tu-104 design dates from 1953. The first flight took place early in 1955. The 70-seat Tu-104A carries 16 first-class passengers with four-abreast seating in a forward cabin, and there are 54 tourist seats—five abreast—at the rear. A typical operational crew numbers four—pilot, co-pilot, navigator and radio operator—and an engineer is optional. Between the pilots there is access to the nose of the aircraft, which houses the navigator's station, as in many last-war bombers. The radio operator's position is behind the co-pilot, facing aft. A fairing beneath the nose houses weather radar.

Precise performance figures for the Tu-104A have not been issued, possibly because of security attaching to its military progenitor. Indicative of its capabilities, however, are the world records set up last September. These included a speed of 970.821 km/hr over a distance of 1,000 km carrying a load of 10,000 kg, and a height of 11,221 m with a load of 20,000 kg.

The swept wing, of moderately thick section, carries Fowler-type flaps, and attached to the trailing edges are prominent fairings for the undercarriage bogies. The fuselage is mainly of circular section.

TUPOLEV Tu-104A

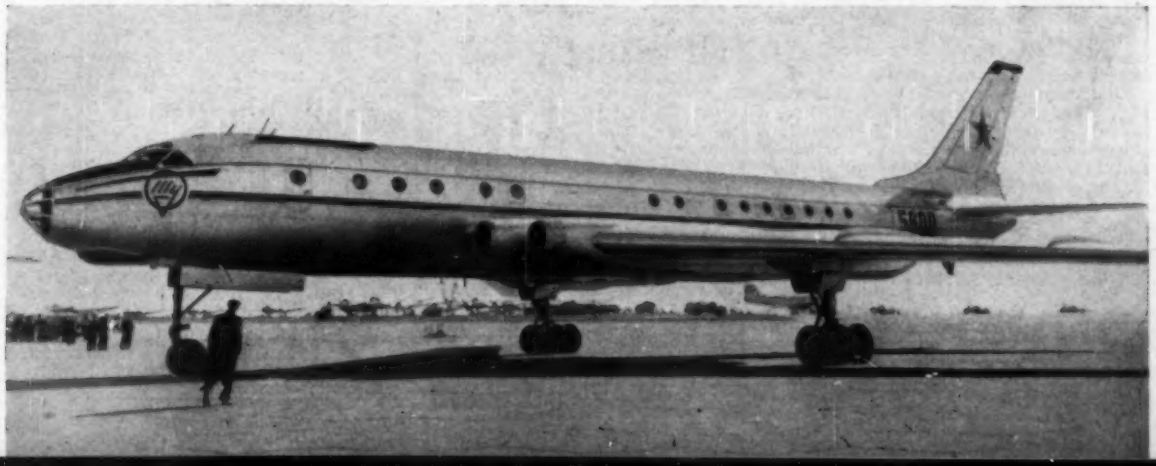
Two Mikulin AM-3s (RD-3s) of about 19,000 lb thrust

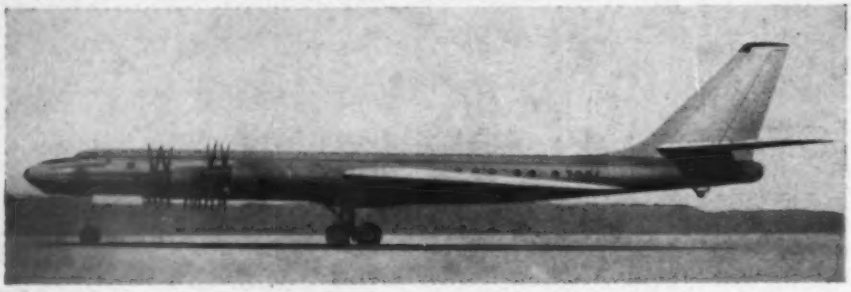
Dimensions: Span, 113.3ft; length, 127.45ft.
Weights: Gross, over 160,000 lb.
Performance: Normal cruising speed, 480-528 m.p.h.; max. speed, over 620 m.p.h.; range, over 2,500 miles.

Tu-110

THIS four-engined development of the Tu-104 is about 10ft longer and has 100 seats. The turbojets are probably of about 12,000 lb thrust each and are thought to have a more favourable specific fuel consumption than those in the Tu-104 series. Their installation has entailed considerable revision of the inboard wing structure and of the flaps, which are now of increased chord. In addition to 100 passengers there is space for 4,000 lb of baggage and 6,000 lb of cargo. Several layouts are proposed. Typically there are three cabins, the first for 30 persons in six rows; the second for 15 in three rows; a third for 55 in 11 rows. All the seats have detachable tables. Between the first cabin and the cockpit is a galley and aft of the third cabin are two wardrobes, two toilets and a vestibule. Stated cruising speed, 800-900 km/hr at 10,000-12,000 m; range, 3,000-5,000 km; max. load, up to 12 metric tons.

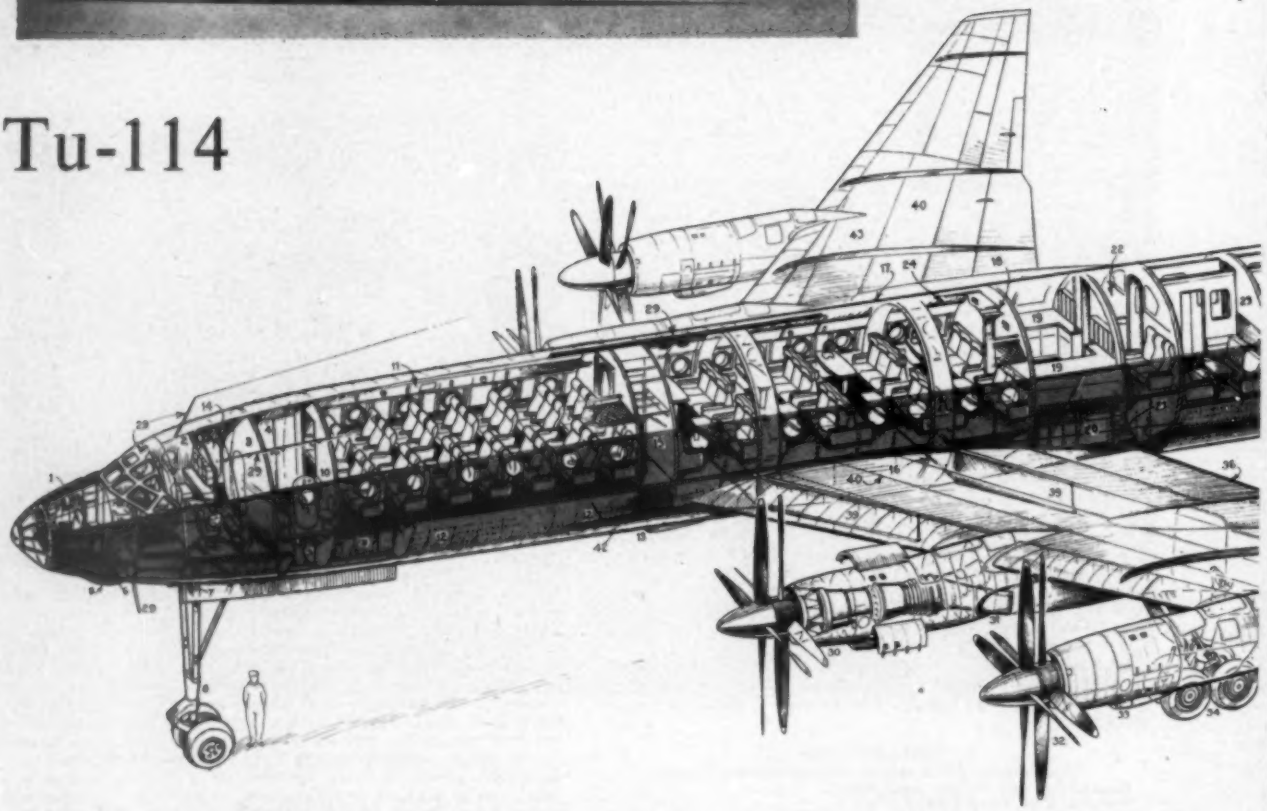
Tu-110.





Above, Tu-114. Left, Tu-114D.

Tu-114



THE Tu-114—a design of Andrei Tupolev—is the world's largest airliner. Furthermore, it is among the fastest, and it probably has a longer potential range than any other. It is a development of the "Bear" bomber as used for several years in the Soviet Air Force, and it has a smaller, ultra-long-range "courier" counterpart in the Tu-114D, the fuselage and tail unit of which are almost identical with those of the Bear.

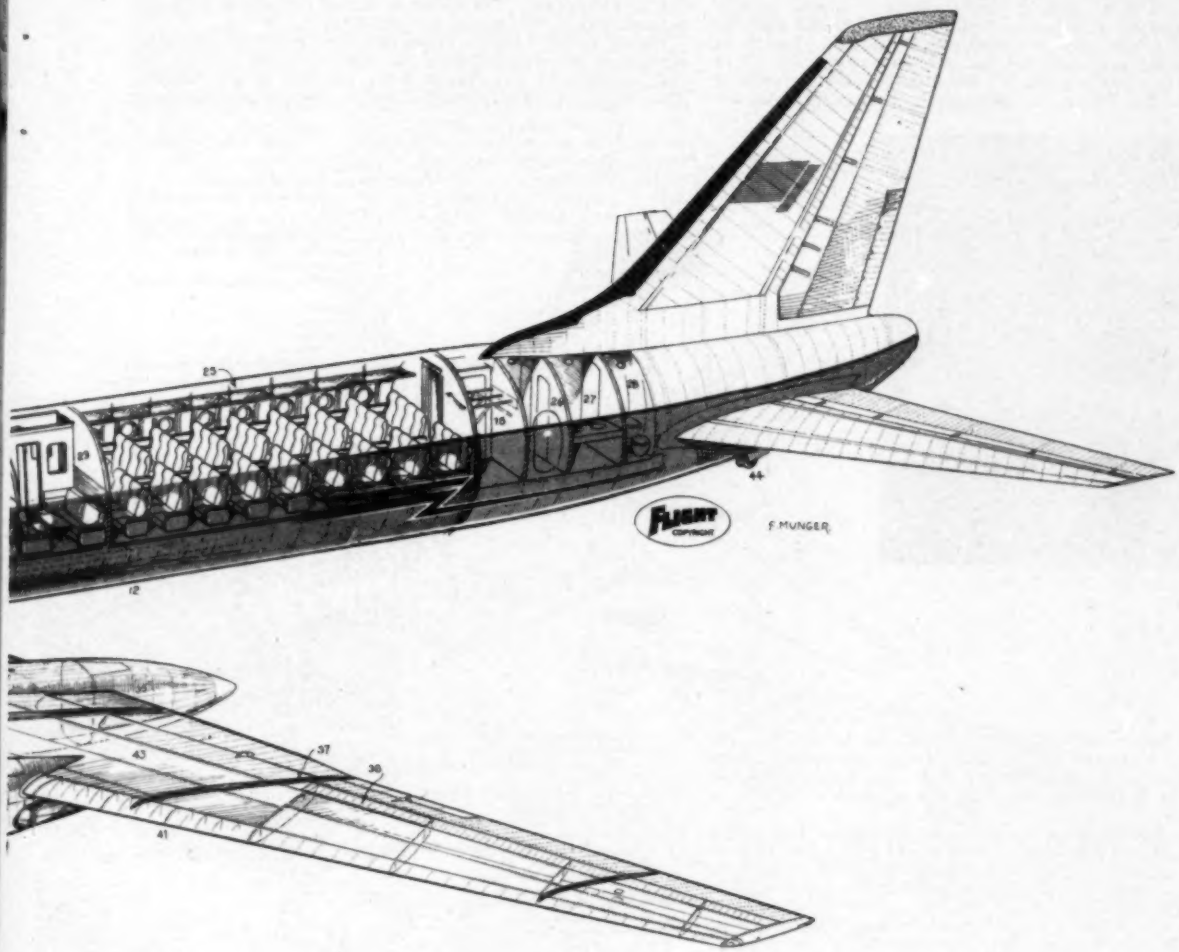
Since the Tu-114 prototype first appeared in the autumn of 1957 it has made numerous demonstration and Press flights and has been extensively publicized, particularly in respect of its capacity and range. The type should enter Aeroflot service next year. A large sectioned model is on view at the Brussels International Exhibition and shows a 170-seat interior. The name Rossiya was applied to the Tu-114 at the time of its first appearance but now seems to have fallen into disfavour.

The engines in the first instance are apparently four Kuznetsov NK-012Ms, each of 12,000 shaft horse-power, driving contra-rotating propellers of over 18ft diameter. The main under-carriage bogies, each with four wheels, retract rearwards into fairings forming the tail-pieces of the inboard nacelles. The controls have power operation.

The 170-seat layout includes tables—each equipped with a shaded lamp—for the alternate forward- and aft-facing seats in the central (restaurant) cabin. By removing these tables and using six-abreast seating, the accommodation can be increased to 220, although the general seat pitch of 36.6in may also suffer. In one announced layout scheme the accommodation is arranged as follows: a vestibule compartment with seats for the stewardesses (of whom there are three) or for passengers waiting to use the toilet; the forward cabin with 41 seats; the restaurant cabin with 48 seats; a cabin with three forward-facing seats opposite the staircase; four pullman compartments seating 24 and an after cabin seating 54.

The back of the three-abreast and two-abreast seats can be inclined from 16 to 40 deg and locked in any of seven positions; the recline angle of the cushion is 12 deg. Downstairs is the

1 Navigator's station
2 Flight engineer and radio/electronics operator
3 Pressure (safety?) bulkhead behind flight deck
4 Forward toilets
5 Radome
6 Search radar
7 Landing/taxi lamp
8 Rearward-retracting, lever-suspension nose gear
9 Nose-gear bay
10 Stewards' seats
11 Forward cabin (42 six-abreast seats shown)
12 Underfloor freight hold; loading door to starboard
13 Cabin-air ram intake
14 Crew entry door
15 Coat stowage
16 Main-spar fuselage frames
17 Centre cabin (48 six-abreast pull-man-type seats shown)
18 Double strip lighting
19 Serving area
20 Pantry on lower deck, two electric lifts to upper deck
21 Stairway
22 Stairway to starboard, three seats (possibly crew rest) to port
23 "Roomettes," each with two divans and one folding bunk, or six seats
24 Folding racks
25 Aft cabin (72 eight-abreast seats shown)
26 Passenger entry door
27 Wash/powder rooms, port and starboard
28 Aft toilets (four)
29 Aerials
30 NK-012M single-shaft turboprop engines
31 Bifurcated exhausts
32 18ft 4in diam counter-rotating reversing propellers
33 Oil-cooler ram-air intake
34 Rearward-retracting main bogies
35 Undercarriage nacelles
36 Fowler-type flaps
37 Boundary-layer fences
38 Spoiler
39 Main-spar booms
40 Parallel skin planks
41 Thermal ant-iced leading edge, 35 deg sweep
42 Ice protection strip
43 Fuel, 176,370 lb
44 Retractable tail-bumper (two wheels)



kitchen, in which are employed two or three full-time cooks and from which the food is despatched by lifts to the stewardesses.

Within the gross pressurized volume of 20,122 cu ft are two underfloor freight holds; most unusually (at least by Western standards), the after one can be entered in flight through a door on the lower deck. The total volume is 2,472 cu ft, and the volume of the pressure cabin 16,423 cu ft. The cabin altitude is held at s.l. equivalent up to about 20,000ft and at an equivalent altitude of 8,000ft above that. Maximum differential pressure is 8.4 lb/sq ft. Temperature is held at 20 deg C and humidity at 20 per cent.

The Tu-114 is capable of cruising at speeds of the order of 500 m.p.h. and the Russians claim that it will be capable of "10-12hr non-stop flights between Moscow and distant points such as Vladivostock, Peking, Tokyo, New Delhi, Rangoon or New York." A Tu-114D recently completed a non-stop flight of 5,280 statute miles from Moscow to Irkutsk and back at an average speed of 497 m.p.h. and at altitudes of between 33,000 and 40,000ft. On the return flight, headwinds of up to 125 m.p.h. were encountered; but sufficient fuel remained on landing for the aircraft to fly a further 930-1,240 miles.

TUPOLEV Tu-114

Four Kuznetsov N -012M or 022K turboprops of 12,000 s.h.p. lus 1,280 kg (2,645 lb) thrust each

Dimensions: Span, 54 m (177ft 2in); length, 47.2 m (154ft. 10in); height, 11.8 m (38ft 8½in); wing area, 280 m² (3,013.9 sq ft); aspect ratio, 10.4; propeller diameter, 5.6 m (18ft 4in).

Weights and loadings: Max. take-off weight, 187,750 kg (413,915 lb); empty weight, 85,400 kg (188,274 lb); fuel, 80,000 kg (176,370 lb); oil, 3,000 kg (6,614 lb); weight of crew (15 in number), 1,350 kg (2,976 lb); remaining allowance for payload, 18,000 kg (39,683 lb) (this can be increased, according to American reports, up to 30,000 kg); max. landing weight, 125,000 kg (275,573 lb); wing loading, 670 kg/m² (137 lb/sq ft); power loading 3.6 kg/e.h.p. (7,936 lb/e.h.p.).

Performance: Max. cruising speed at 9,000 m (29,530ft), 910 km/hr (565 m.p.h.); at 10,000 m (32,808ft), 855 km/hr (531 m.p.h.); take-off at full weight, 272 km/hr (170 m.p.h.); landing speed, 205 km/hr (125 m.p.h.); time to 10,000 m, 36.5 min; "practical ceiling," 10,400 m (34,120ft); "normal range," 10,000 km (6,214 miles); "max. range," 14,500 km (9,010 miles); take-off distance to 15 m (50ft, presumably field length), 2,850 m (9,350ft); landing distance from 15 m, 1,800 m (5,900ft) with reverse pitch, 2,650 m (8,690ft) without.

Il-18

THE Il-18 is perhaps the most challenging of all the new Russian transports in that it is generally comparable with the Vanguard and Electra, and is expected to sell in the export market at about a million dollars. Designed by Sergei Ilyushin, the first aircraft of this type was flown last year and before the end of the present year it will be in Aeroflot service. Models displayed at Brussels show 75- and 100-seat variants. The aircraft is intended for routes such as Moscow - Irkutsk or Moscow - Delhi non-stop, and has a still-air range with 1½ hr fuel reserve of 3,100 st. miles, or 1,860 with the maximum payload of 30,900 lb. The Russians are particularly proud of the Moscow's disposable load to take-off weight ratio of over 50 per cent. The engine are Kuznetsov N.K.4 4,000 e.h.p. turboprops, driving AB-68B four-bladed propellers 13.7ft in diameter; and, like the An-10A, the Il-18 is claimed to be able to cruise at 16,000ft on two engines.

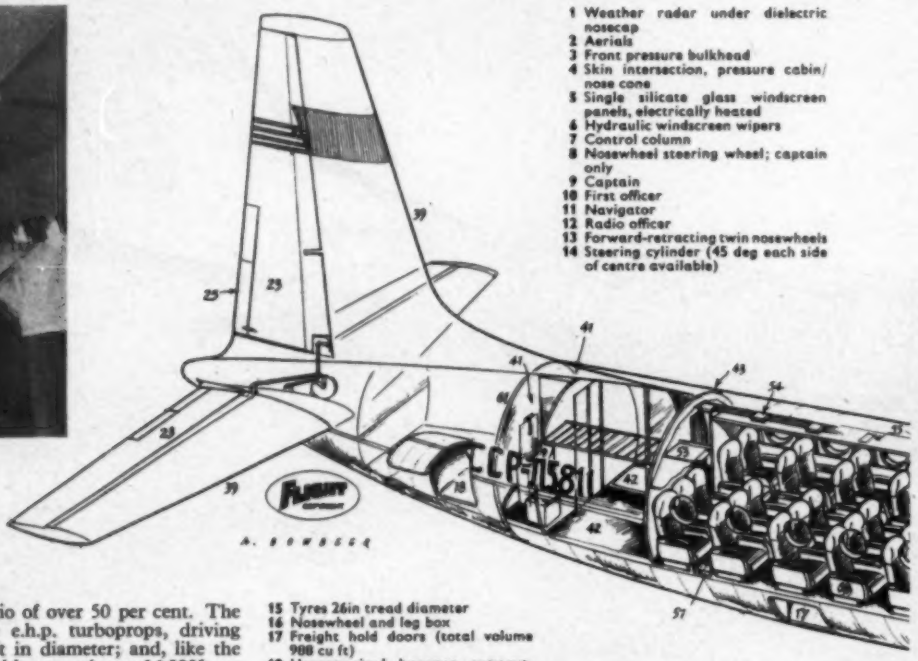
The fuselage structure is apparently conventional monocoque, pressurized to an equivalent altitude of sea level up to 17,000ft, 5,000ft at 26,000ft, and 7,800ft at a cruise altitude of 32,000ft; the maximum differential pressure is 7.1 lb/sq in. Air is supplied from compressor bleed for air conditioning and 30 changes per hour are made in the 8,830 cu ft internal volume. The cabin doors measure 55in×30in. There are three cargo holds: the compartments forward of the wing and aft of the wing each have a volume of 495 cu ft and there is a further unpressurized hold aft of the pressure bulkhead, measuring 600 cu ft. The cargo access doors measure 47in×35in. A compartment for carry-on passenger baggage has a volume of 247 cu ft.

The wing is made in three parts, a centre section 72ft long and extension planes. The centre section is of three-spar construction with 47 ribs and a total of 36 stringers. The skin thickness varies from 5.0 mm to 2.0 mm. The outer wings have two spars which, with the 1.5 mm skins, form the boundary members of an integral tank. There are 18 ribs and 27 stringers. Fuel is also contained in flexible bag tanks in the centre section and the total capacity is 5,280 Imp. gal, although another version with integral tanks in the centre section has a total fuel capacity of 5,940 Imp. gal. Titanium sheeting (forming problems have largely been overcome) is used to shroud the jet-pipes and in the wheel wells.

The flying control system is straightforward. The rudder is equipped with a spring tab and trim tab and the elevator with a trim tab only. With one exception—the Tu-114—all the new Russian civil aircraft have manual, aerodynamically-balanced surfaces. Dural tube push-pull rods are used.

The undercarriage of the Il-18 is equipped with 900 mm×285 mm tyres on the mainwheels and 700 mm×250 mm on the twin nosewheels. The tyre pressure is 92.4 lb/sq in at 119,000 lb take-off weight. Hydraulic pressure is supplied by two NP-25 plunger-type pumps at a system pressure of 3,000 lb/sq in, and a flow of 8 gal/min. The system is backed with nitrogen-charged accumulators in steel bottles at 2,100 lb/sq in.

Electric power is supplied from eight 12kVA variable-frequency alternators. Starter-generators are used, and these provide 28V DC current, 24V DC current being supplied by the batteries. Alternating current is required in quantity for the de-icing system



1 Weather radar under dielectric nosecap
2 Aerials
3 Front pressure bulkhead
4 Skin intersection, pressure cabin/nose cone
5 Single silicate glass windscreen panels, electrically heated
6 Hydraulic windscreen wipers
7 Control column
8 Nosewheel steering wheel; captain only
9 Captain
10 First officer
11 Navigator
12 Radio officer
13 Forward-retracting twin nosewheels
14 Steering cylinder (45 deg each side of centre available)

15 Tyres 26in tread diameter
16 Nosewheel and leg box
17 Freight hold doors (total volume 988 cu ft)
18 Unpressurized baggage compartment (247 cu ft)
19 Pressure bulkheads at wing cut-out
20 Three-spar centre wing panel
21 Outboard limits of 20 (about 72ft span)
22 Fuel tanks: nine per wing
23 Mass-balanced surfaces
24 Mass-balanced and aerodynamically compensated surfaces
25 Spring-loaded tabs
26 Side and centre consoles
27 Kuznetsov N.K.4 turboprops: 4,000 e.h.p.
28 Hinged side cowlings
29 Auto feathering, reversible propellers with built-in anti-windmilling lock
30 Radar scope at top of instrument panel (scope can be swung aside for use by either pilot)
31 Area-increasing flaps
32 Jet pipes over wing
33 Forward retracting undercarriage (hydraulic actuation)
34 Jack folds wheel-beam against leg before retraction
35 Radius rod
36 Sway braces with nacelle doors

which uses electro-conductive elements on the leading edges of the wings, fin, tailplane, propeller blades, spinners, engine intakes and windscreen. The Moscow is equipped with cloud-and-collision-warning nose radar called *Emblema* that can be used for map-painting and for ground radar beacon identification. A navigation computer is fitted that operates on a system of pre-set co-ordinates. The designation of this equipment is NI-50BM-3.

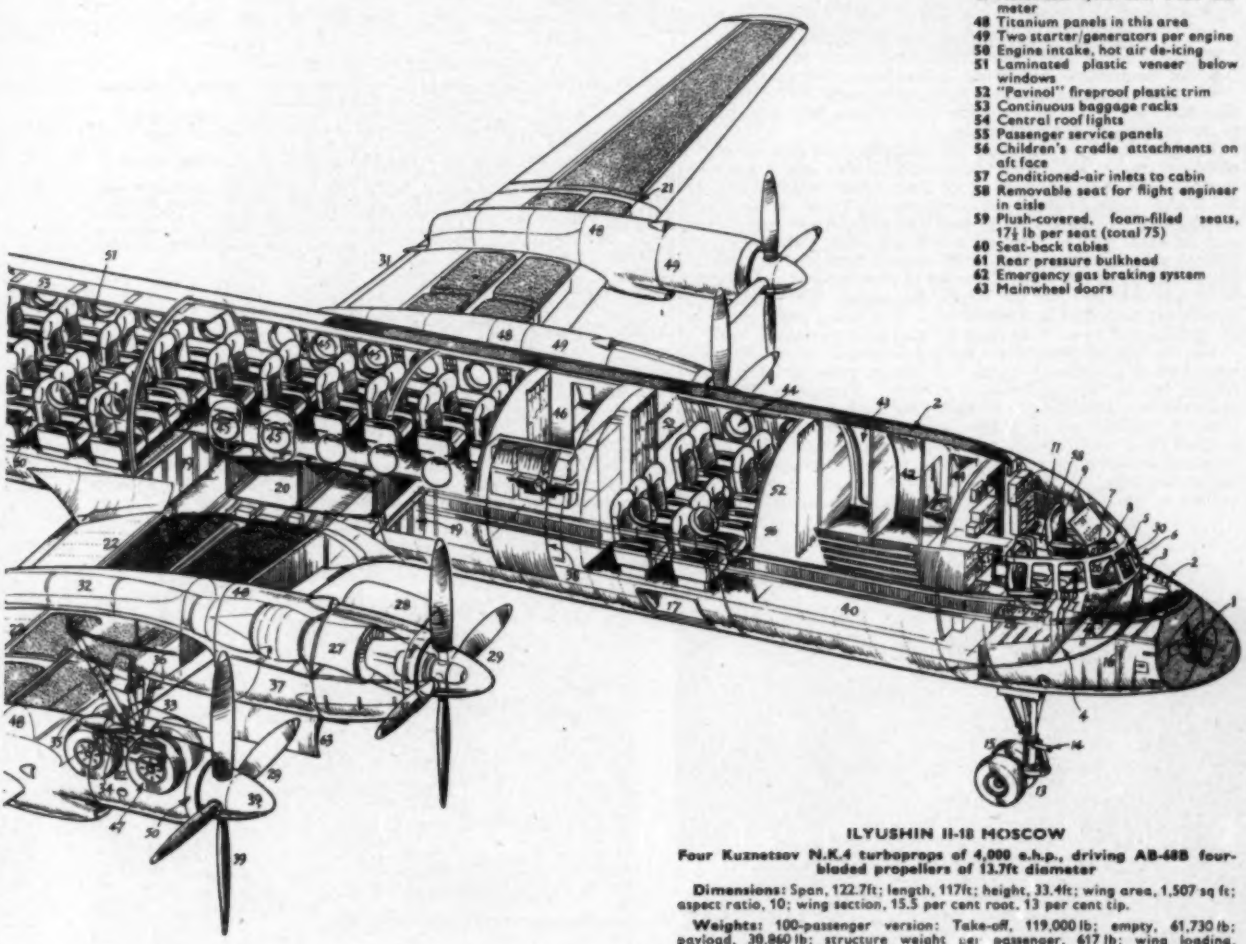
Electronics include H.F., two V.H.F., two A.D.F., radio altimeter, I.L.S., and marker beacon receivers.

Instruments, in uncrowded and orderly array, are distributed on grey panels; and the ample windscreen sections, two of them electrically heated, offer excellent forward, sideways and upward visibility. Notable features of the fairly plain flight instruments are a turn-and-slip indicator calibrated in degrees of bank up to 45 deg for a speed of 500 km/hr, standard Western-type I.L.S. dial, logarithmic V.S.I. scales, miniaturized engine torque gauges, electric warning notices rather than plain red lights, and several dual-reading engine gauges.

Particularly notable are single-lever engine controls, and twin radar tubes (with brightness and focus controls) on a swivelling mounting, apparently serving search-type radar capable of using ground-based radar beacons. The autopilot, mounted below the ratchet-controlled throttle levers, has wheel and knob controls for all three axes, a warm-up setting and switches for gyros and heading lock. The flying control locking lever is next to the throttles. Beneath the co-pilot's flight panel separate dials show the position of each main undercarriage leg, a light panel shows undercarriage-lock positions; and there is a flap-position dial. Beside the captain's panel are two A.D.F. dials and roof panels. The central roof panel is for fire extinguishing and carries full instructions, a schematic diagram of the system and green lights to show fluid discharge.

Engine instruments, centrally located, include (left to right and downwards) two twin r.p.m. dials in per cent; two twin temperature-gauges; four miniature torque dials; two twin oil-pressure gauges; a fuel gauge reading to 12,000 litres; propeller setting and pitch-stop control selector, circuit breakers and warning lights; the second 12,000 litre fuel gauge; and four fuel-flow gauges reading up to 1,500 litres/hr on an outer scale and up to 6,000 on the inner scales. Propeller brake and reverse-pitch controls are to the left of the autopilot and speed governor switches set for 15,000 r.p.m. and 14,300 r.p.m. are to the right.

Undercarriage and flap controls are probably beyond the throttles, while radio, fuel system and pressurization controls will be on the long consoles outboard of each pilot. Access to their seats is round the outside, Stratocruiser-fashion. Toe pedals control the wheel brakes. The right-hand (and left-hand) windows probably pull in and slide back.



37 Bogie bay under firewall
38 Ice-protection strip
39 Electro-thermal de-icing
40 Baggage hold 247 cu ft
41 Toilets
42 Wardrobes
43 Doors (pull-in and slide)
44 16in windows
45 Emergency exits
46 Buffet/galley
47 Mainwheel tyres 33in tread diameter
48 Titanium panels in this area
49 Two starter/generators per engine
50 Engine intake, hot air de-icing
51 Laminated plastic veneer below windows
52 "Pavinol" fireproof plastic trim
53 Continuous baggage racks
54 Central roof lights
55 Passenger service panels
56 Children's cradle attachments on aft face
57 Conditioned-air inlets to cabin
58 Removable seat for flight engineer in aisle
59 Plush-covered, foam-filled seats, 17½ lb per seat (total 75)
60 Seat-back tables
61 Rear pressure bulkhead
62 Emergency gas braking system
63 Mainwheel doors

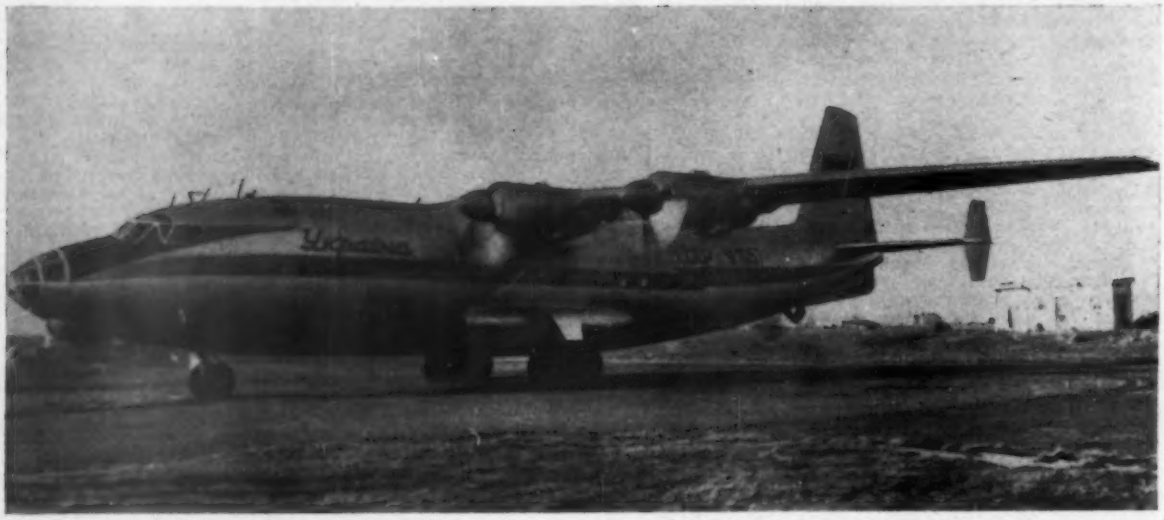
ILYUSHIN Il-18 MOSCOW

Four Kuznetsov N.K.4 turboprops of 4,000 e.h.p., driving AB-68B four-bladed propellers of 13.7ft diameter

Dimensions: Span, 122.7ft; length, 117ft; height, 33.4ft; wing area, 1,507 sq ft; aspect ratio, 10; wing section, 15.5 per cent root, 13 per cent tip.

Weights: 100-passenger version: Take-off, 119,000 lb; empty, 61,730 lb; payload, 30,860 lb; structure weight per passenger, 617 lb; wing loading, 79 lb/sq ft; power loading, 7.5 lb/e.h.p.; fuel capacity, 3,210 gal. Seventy-five-passenger version: take-off, 127,870 lb; empty, 61,730 lb; payload, 26,450 lb; structure weight per passenger, 824 lb; wing loading, 84.9 lb/sq ft; power loading, 7.93 lb/e.h.p.; fuel capacity, 5,280 gal.

Performance: Cruising speed, 403 m.p.h., at 26,250ft; range with 1 hr fuel reserve, 1,860 miles; take-off distance, 2,460ft to 2,950ft; landing distance 1,640 to 1,970ft.



An-10A Ukraine

THE An-10A is the first production version of the An-10—an impressive high-wing monoplane designed by Oleg Antonov which has been flying since early 1957. Since the first flight of the An-10 prototype auxiliary fins have been added to the extremities of the tailplane.

The type has been designed, expressly for Aeroflot, to operate when necessary from grass fields, and to that end the undercarriage—the main units of which retract into large fairings on the flanks of the fuselage—has low-pressure tyres. Mounted on the high-aspect-ratio wing are four Ivchenko AI-20 turboprops, each of 4,000 e.s.h.p. The propellers are steel, reversible, four-bladers, with automatic feathering. Slotted flaps are fitted and all fuel is carried in the wing. De-icing is provided not only for the wing and tail but for the engine-air intakes, oil temperature regulators, propellers and windscreen. The cabin and flight deck are pressurized by air bled from the engine compressors.

The An-10A accommodates 100 passengers in six-abreast seats, and there is generous baggage and freight provision. (A pure-freight version is an obvious possibility.) The pilots' seats are mounted on high pedestals, with a considerable step up from floor level. A third crew-seat is in a deep well behind the pilots and reached by a two-step companionway from the cabin bulkhead door into the crew compartment. The navigator occupies a seat in the glazed nose, which is adjustable fore and aft upon rails and swivels to allow its occupant to reach the radio equipment racks and radio console to port, or the navigation table and radar scanner to starboard.

It is claimed that the aircraft can maintain height on two engines at 16,000ft.

ANTONOV An-10A UKRAINE

Four Ivchenko AI-20 turboprops of 4,000 e.s.h.p., driving four-blade propellers of 14.8ft diameter

Dimensions: Span, 124.7ft; length, 121.3ft; height, 32.1ft; fuselage diameter, 13.4ft; wing area, 1,293 sq ft; cargo hold volume, 1,483 cu ft; passenger cabin volume, 7,840 cu ft.

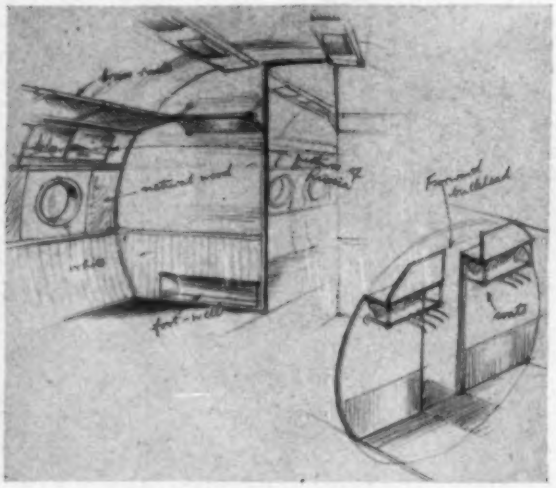
Weights: Take-off, 121,500 lb; payload, 32,000 lb; wing loading, 88 lb/sq ft; power loading, 7.2 lb/sq ft; fuel weight, 22,600 lb.

Performance: Max. speed at 26,250ft, 483 m.p.h.; range at 32,000ft with 1 hr fuel reserve (payload 32,000 lb), 1,240 miles; with payload 23,000 lb, 1,927 miles; with payload 18,600 lb, 2,127 miles; take-off run, 2,130ft-2,300ft; landing run, 2,130ft-2,300ft; landing run with reversing propellers, 1,640ft; rate of climb (s.l.), 1,960ft/min; s.l. climb with one engine out, 1,278ft/min; with two engines out, 472ft/min.

An-16

THIS development of the An-10 was first announced at the opening of the Brussels International Exhibition. The fuselage is stretched by 3 m (9.8ft), enabling 130 seats to be installed, and the design is further modified to give an under-floor cargo-hold height of almost 4ft. There is no evidence that this development has yet flown, although it is known that by last April between ten and fifteen An-10As had been completed.

Top, An-10 Ukraine prototype. Below, the cabin of the same aircraft; and right, interior details of the An-10A.



Bound for Paris
across European cornfields

or Puerto Ordaz
over the forests
of the Orinoco

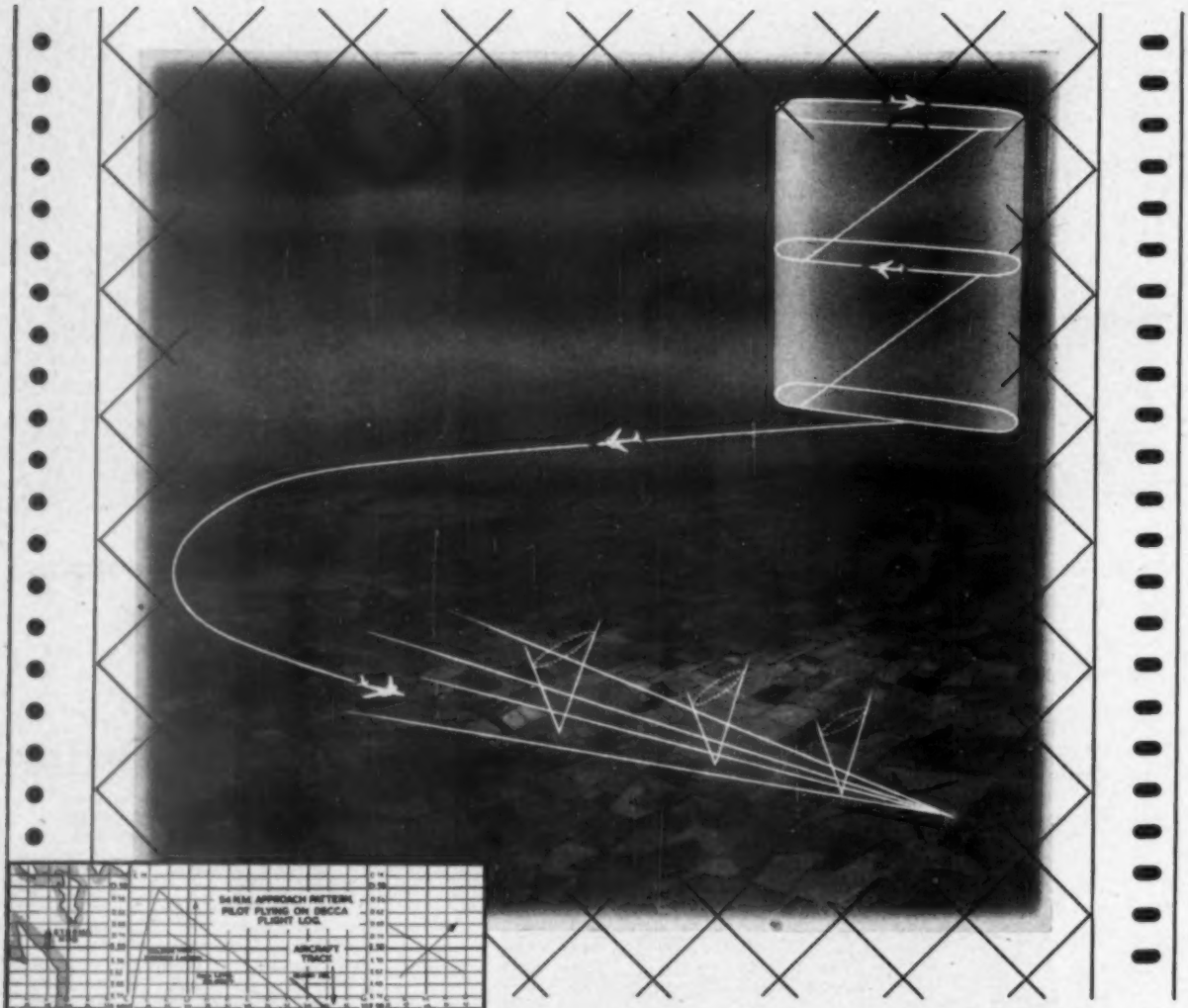
the Dart Herald is a fast, adaptable airliner for the shorter routes. It carries up to 43 passengers in a style to which any traveller gladly becomes accustomed. They relax in pressurised, air-conditioned comfort, enjoying the smoothness of turboprop flight.

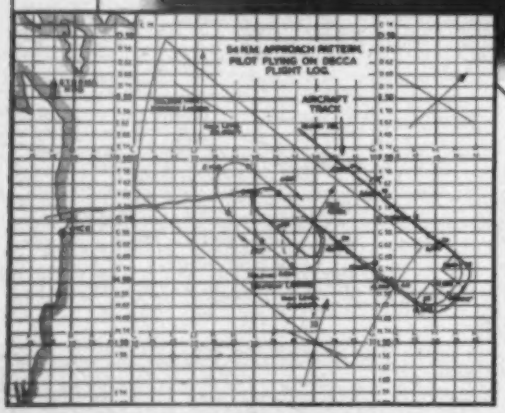
Alternatively, the Herald takes over 4½ tons of cargo or combinations of passengers and freight. Between cabin and hold is a partition which can be set in several positions to give differing passenger and cargo space for each flight.

DART
Herald

Engines: Two Rolls-Royce Dart Propjets

HANDLEY PAGE · RADLETT LONDON · READING





In the trials held off the Orkneys, the holding area and runway were simulated exactly as for London Airport. In the above chart, used during the trials, the holding area with 4, 6 and 8 minute orbits is clearly shown together with the required track to the runway also clearly marked with altitude checks down to the threshold. With the Flight Log the pilot was able to navigate precisely at every stage of the flight, greatly simplifying the entire holding and approach procedure.

THE DECCA NAVIGATOR

THE WORLD'S MOST ACCURATE NAVIGATION SYSTEM

THE DECCA NAVIGATOR COMPANY LIMITED, LONDON, ENGLAND

Decca in the Jet Age

Recent air traffic control trials carried out by the Ministry of Transport and Civil Aviation in a D.H. Comet have proved that, with the Decca Navigator Flight Log, jet aircraft can be navigated accurately regardless of altitude or weather conditions.

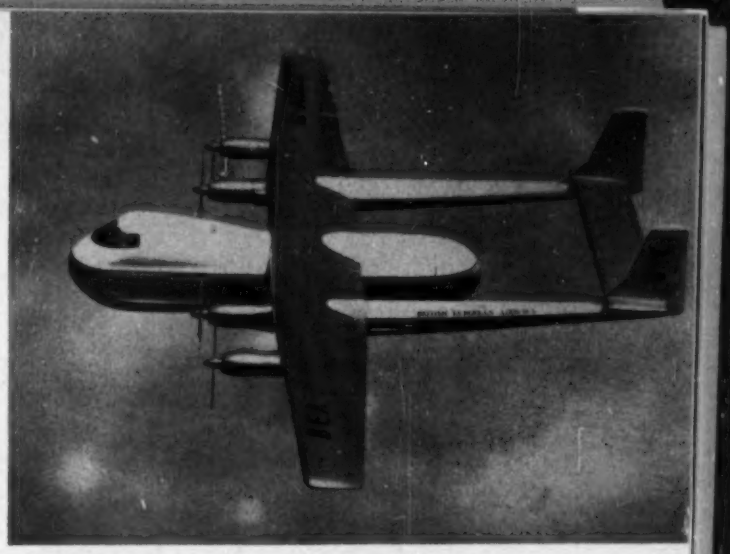
No other aid is either suitable or accurate enough for holding at altitude within a defined area. With Decca, such areas can be designated independently of ground facilities and flown exactly, regardless of drift. Exhaustive tests showed that, with the Flight Log, pilots were able to leave a holding area with a very high degree of precision, track can be maintained precisely during the descent from the holding area to touch down, giving the pilot a continuous check of altitude against distance from touch down.

Knowing exactly where he is at all times by reference to his pictorial display, the pilot has an independent check on radar control, and being able to navigate himself accurately in the terminal area his R/T communication with the ground is greatly reduced. The safety of all aircraft is increased by the consequent lightening of the load on the Radar controller. Improved accuracy in time and position keeping, results in the reduction of delays enabling the maximum landing rate to be achieved.

Argosy

and Derivatives

Sir W. G. Armstrong Whitworth Aircraft, Ltd.,
Baginton, Coventry



TWO big problems face the world's air transport industry and the British manufacturers supplying equipment for it. One is the pace of technological development, which has brought the airlines to the brink of the biggest re-equipment programme in the industry's history, and which is reflected in the airlines' present critical financial situation. The other problem—one which faces British manufacturers in particular—is that in the present nuclear age diminished military contracts make it necessary to turn more and more to civil manufacture.

The Hawker Siddeley Group, of which Armstrong Whitworth is a member, have shown in the AW.650 Argosy that they recognized these trends two years ago. This aircraft is the kind of transport which is not likely to be technically outpaced for many years to come; and it is being wholly financed—to the tune of about £10m—by the Hawker Siddeley Group.

Above all, it is in production, an acknowledgement of the fact that the days of building and testing a prototype prior to the receipt of orders are gone for ever. Three "prototypes"—which are in fact standard aircraft off production jigs—will be flown in quick succession for manufacturer's and airworthiness trials, and seven production aircraft (one of which will be a sales demonstrator) are to follow during the course of 1959. The first of the three "prototypes" is due to fly before the end of the year, and production deliveries of aircraft fully certificated to both U.K. and U.S. civil airworthiness standards can be made in the early part of 1960.

The Argosy is essentially a transport designed to bring down the cost of air freight; it is a tool with which the airlines can prise open a market which, because suitable specialized aircraft have not been available in the past, has immeasurable potentialities. These will never be realized so long as air transport costs are three, four or five times higher than those offered by the three kinds of surface transport, road, rail and sea. The Argosy is intended to cut air freight rates down to the level which will attract those freight shippers who—while having always recognized the speed and convenience of air freight—have in the past regarded its cost as beyond their means.

But significantly low though the Argosy's costs are, they are nevertheless not so low as to justify airlines buying it for this purpose alone. To achieve air freight costs of a level comparable with surface transport, a really huge-capacity aircraft is required; but the problem of filling such capacity is the reason why such aircraft are not likely to be acquired in large numbers for many years to come. The airlines have been used to developing freight business with machines designed primarily for passenger use, or by actually carrying freight on board passenger aircraft. They are naturally hesitant to make an immediate transition to equipment designed specially for freighting (however attractive it may be), simply because the investment would not be justified by the existing volume of business. For these reasons, Armstrong Whitworth have designed the Argosy to be readily adaptable for passenger-carrying work as well as for freighting, and accommodation for between 70 and 80 passengers is provided. Thus, in one vehicle, the airlines can buy a turboprop airliner with the comfort and smoothness and amenities of a Viscount, and with the load-carrying qualities (front and rear loading, pressurization, large volume) of a specialized freighter.

For good measure, Armstrong Whitworth offer variants of the basic AW.650 Argosy which, by virtue of its twin booms, can have practically any kind of fuselage container applied to it. Variants at present being offered are the AW.660, a military adaptation with a "beaver-tail" door which opens in flight for the dropping of fighting equipment and troops (this version offers also the facility of ramp-loading); and the AW.670 Airbus, an unpressurized variant designed especially for vehicle ferry work. This latter version is adaptable also as a high-density coach, in which rôle it will accommodate up to 126 passengers.

COMMERCIAL HISTORY With the sales of all variants in the hands of the Hawker Siddeley Group backed by the widespread Rolls-Royce sales organization, commercial success seems as assured as it can be for a new project. Models of the Argosy have appeared in the markings of B.E.A., and the AW.670 car ferry in Silver City and Jersey Airlines livery, but no orders have yet been announced. Plans for the AW.660 military version were revealed last July.

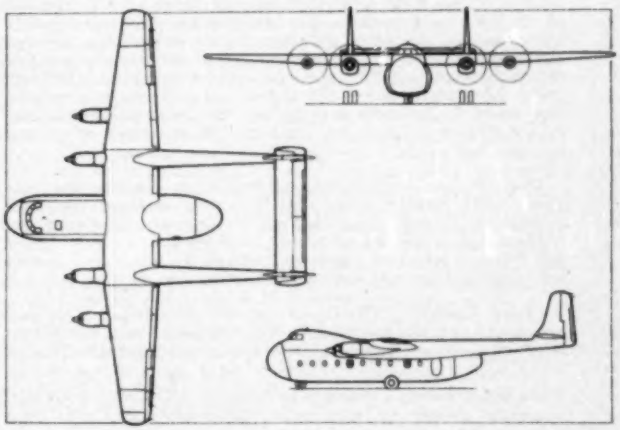
Initial production of ten aircraft—all 650s—may be speculative, but it is convincing evidence of A.W.A.'s belief in the marketability of their product. Interest in the aircraft is likely to sharpen when the first aircraft is in the air. A.W.A. intend to make world-wide demonstration tours with the fourth production aircraft (which will be allocated solely to the sales department), starting next June at the Paris Salon. Thereafter, the aircraft will tour Europe, the Middle and Far East, Australia, New Zealand, South America, the U.S.A. and Canada.

STRUCTURE Of particular interest as an exercise in structural design are the large fore and aft freight doors giving full axial loading accessibility to the capacious pressurized fuselage. Each door swings sideways on two hinges and a thrust bearing. The side-hinged doors are opened and closed by a manually or electrically operated nut and lead screw gear. Locking is by a hydraulic multi-jack system operated by a hand pump. The wings, which are being designed and constructed by A. V. Roe and Co. (another member of the Hawker Siddeley Group), are derived from those of the Shackleton. The mainplane is of twin-spar construction, carrying ten bag-type fuel tanks between the spars. A continuous skin is used throughout with the exceptions of the undercarriage bay and the centre section, where there is no lower skin. Design of the tail unit is being undertaken in collaboration with the Gloster Aircraft Co., also a member of the Group.

Armstrong Whitworth make an important claim for the fatigue life of the AW.650 structure. This is as follows:—

"The primary structure is so designed that a fatigue life of 30,000 hours shall be achieved on typical high-altitude short-range stages, e.g., 500 n.m. cruising at 25,000ft. The life for low-altitude very short-range operations is correspondingly reduced, whilst that for long-range high-altitude stages is improved over the 30,000-hour life. This means that during this period none of the structure integral with the airframe, such as the wing, fuselage, tail booms and tail unit will fail through fatigue, giving subsequent catastrophic structural collapse. The foregoing does not include parts which are readily replaceable or can be repaired during normal servicing and maintenance, e.g., windscreen panels and cabin windows. In order to provide data on fatigue life, fatigue meters of an approved type are installed on each aircraft. It has been the design policy to ensure that, even after 30,000 hours' life, the fatigue failure is in the form of cracks which can be inspected on the ground."

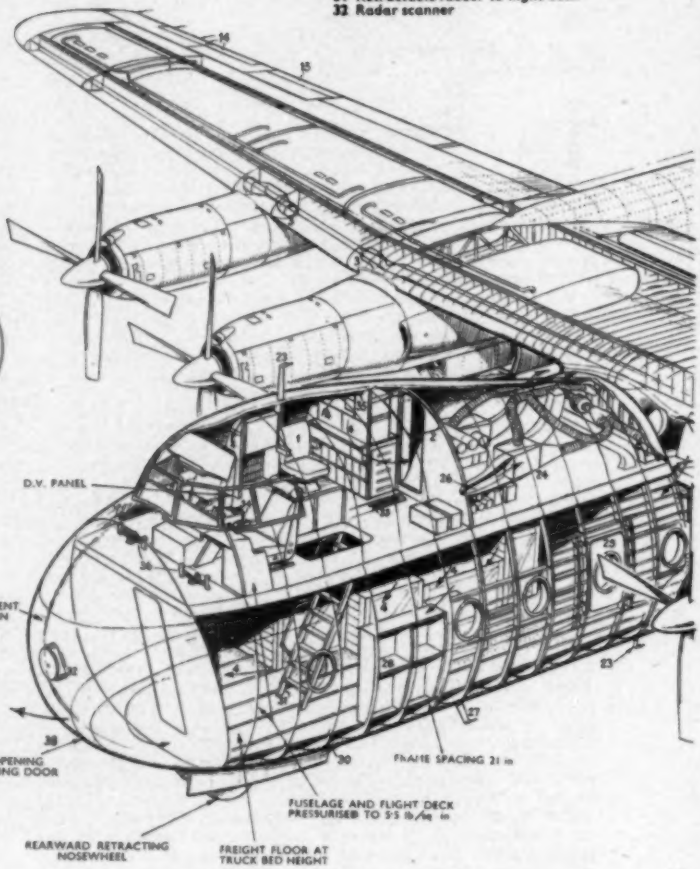
Undercarriage This is by Dowty. Lowering of the main unit is achieved by a controlled free-fall action. The four main undercarriage wheels are fitted with Dunlop hydraulic brakes incorporating a Maxaret anti-skid unit; tyre pressure is 78 lb/sq in main wheels (L.C.N. 28), and 70 lb/sq in nosewheels.



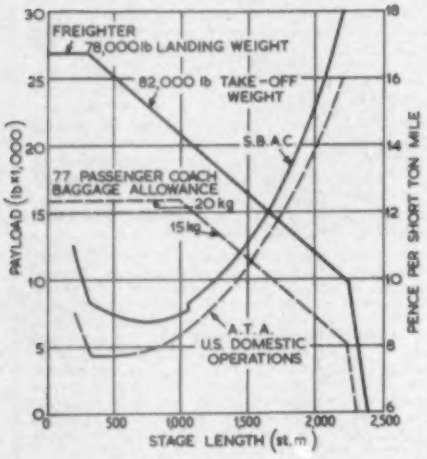
Argosy . . .

1 Seat for supernumerary
2 Crew escape hatch
3 Leading-edge thermal de-icing ducts
4 Airflow from distribution duct in fuselage
5 Service door
6 Navigation light
7 Trim tab
8 Spring tab
9 H.F. aerial
10 Trim-cum-geared tab
11 Spring tab
12 Passenger door
13 Fairlead channels
14 Spring tabs
15 Trim-cum-geared tab
16 Geared tab
17 De-icing air outlets
18 Fuel-tank vent pipes
19 Tubeless tyres, wheels and Maxaret brakes
20 Oil cooler
21 Nacelle support struts from front spar
22 Jet-pipe
23 V.H.F. aerials
24 Heat exchanger
25 Four escape hatches
26 N.A.C.A. cooling-air intakes
27 Pitot head
28 Cupboard
29 Nineteen double-pane windows, clamped into position
30 Nosewheel door fairing
31 Retractable ladder to flight deck
32 Radar scanner

FUSELAGE SECTION


D.V. PANEL
BAGGAGE COMPARTMENT AND CREW TOILET IN FORWARD DOOR
SIDEWAYS OPENING FREIGHT LOADING DOOR
FRAME SPACING 21 in
FUSELAGE AND FLIGHT DECK PRESSURISED TO 5·5 lb/sq in
REARWARD RETRACTING NOSEWHEEL
FREIGHT FLOOR AT TRUCK BED HEIGHT

Payload-range and cost-range performance for the AW.650 Argosy. The cost curves are to the S.B.A.C. and A.T.A. methods.



POWERPLANT Four Rolls-Royce Dart 526 RDa.7/2 turboprops are installed; these powerplants are identical back to the fireproof bulkhead with those fitted to the Vickers Viscount 810. The complete powerplant kit is supplied by Vickers-Armstrongs (Aircraft), Ltd. Larger diameter propellers are, however, used—11ft 6in Rotol four-blade units as compared with the 10ft of the Viscount propellers. As already noted, alternative powerplants are two Rolls-Royce Tynes. As yet, only design work on this alternative installation has been carried out, but it is probable that the advantages of lower weight and better fuel economy will make the Tyne-powered AW.650 an attractive proposition at a later stage. In the meantime, the main emphasis in the marketing of the Argosy is upon the Dart installation, which is proven, available and ready.

Fuel Fuel is contained in ten bag tanks between the wing spars, total capacity 3,300 Imp. gal. Two water-methanol tanks, one in each boom, feed each pair of engines to restore engine take-off performance in high temperatures. Each has a capacity of 82 Imp. gal. Pressure refuelling points for fuel and water-methanol systems are positioned on each main undercarriage leg.

Flying Controls The flying controls are quite conventional spring tab controls operated through push-pull rods, the Smiths Flight System giving the choice of normal manual control, manual

ARMSTRONG WHITWORTH AW.650 ARGOSY

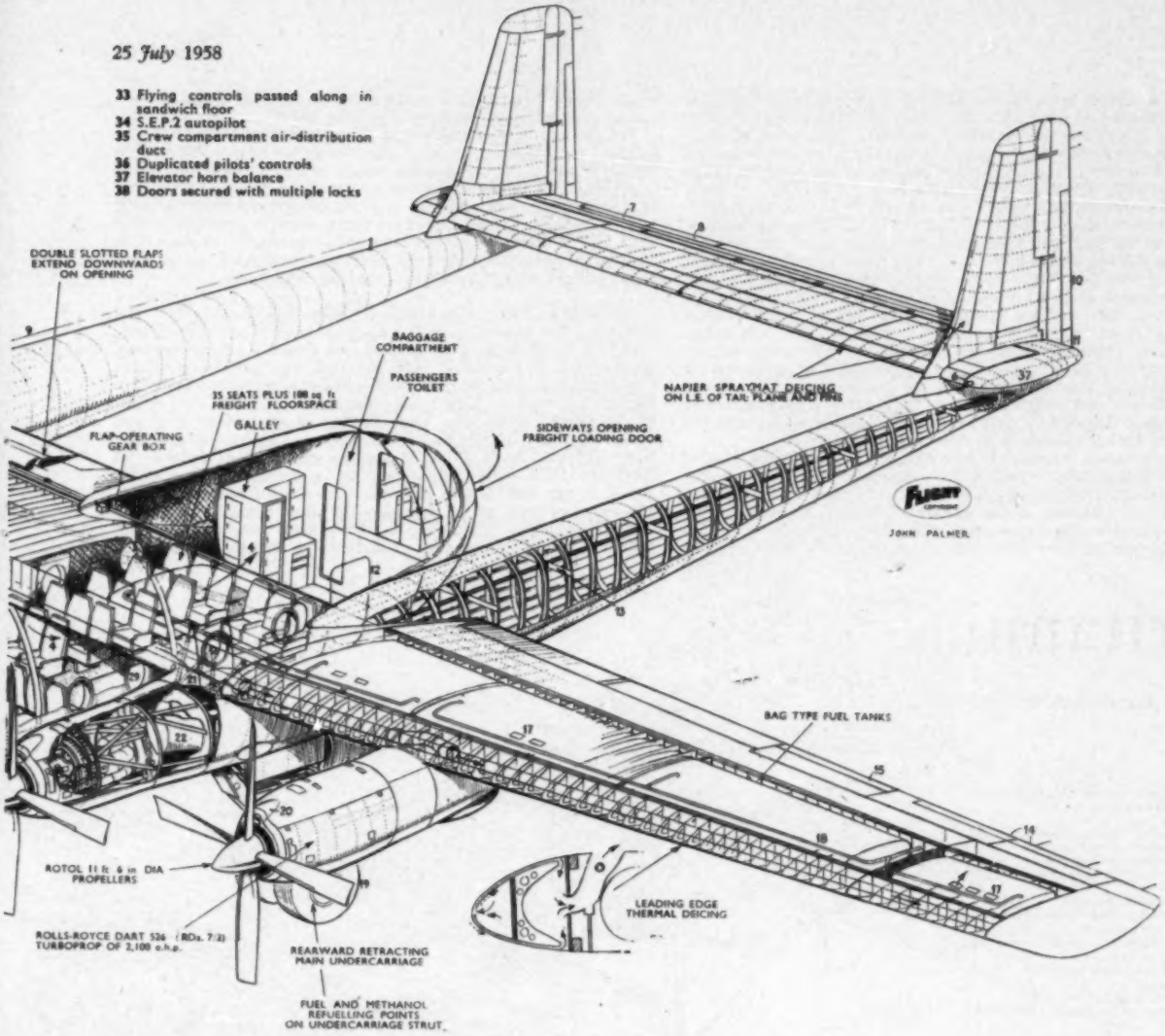
Four Rolls-Royce Dart 526 RDa.7/2 of 2,100 e.h.p.

Dimensions: Span, 115ft; length, 86ft 9in; height, 27ft; wing aspect ratio 9.07; fuselage length, 60ft 7in; fuselage width, 12ft 6in max.; freight floor area, 426 sq ft; freight hold volume, 3,680 cu ft; forward loading door height and width, respectively, 6ft 8in and 8ft 4in min.; rear loading door height and width, respectively, 6ft 8in and 8ft 8in min.; wing area, 1,458 sq ft; wheel track, 32ft 6in; wheel base, 25ft 5in; min. turning radius, 36ft.

Weights: Max. take-off, 82,000 lb; max. landing, 78,000 lb; max. with zero fuel, 74,000 lb; max. payload, 28,000 lb; capacity fuel, 26,400 lb; operating empty weight, 46,000 lb; payload and fuel, 36,000 lb; empty weight, 45,350 lb.

Performance: Max. range without reserves and with 9,450 lb payload, 2,800 st.m.; mean cruising speed, 276 m.p.h. at 13,600 r.p.m.; 296 m.p.h. at 14,000 r.p.m.; three-engined ceiling, 20,200ft; take-off (all engines) 3,200ft in standard conditions without water injection; rate of climb, sea level, max. weight, standard conditions, 950ft/min; fuel consumption, at 290 m.p.h. and 70,000 lb weight at 18,000ft, 0.098 s.m. per lb; landing distance to British requirements, dry surface, 78,000 lb weight, standard conditions, 2,920ft; range with 20,000 lb payload, 1,600 statute miles; approach speed, 117 m.p.h.

The AW.670 Airbus, a vehicle-ferry version or alternatively a 126-seat passenger airliner for short-range high-density coach-class work.


33 Flying controls passed along in sandwich floor
34 S.E.P.2 autopilot
35 Crew compartment air-distribution duct
36 Duplicated pilots' controls
37 Elevator horn balance
38 Doors secured with multiple locks
DOUBLE SLOTTED FLAPS EXTEND DOWNWARDS ON OPENING
BAGGAGE COMPARTMENT
PASSENGERS TOILET
35 SEATS PLUS 100 sq. ft. FREIGHT FLOORSPACE
GALLEY
FLAP-OPERATING GEAR BOX
SIDEWAYS OPENING FREIGHT LOADING DOOR
NAPIER SPRAYMAT DEICING ON L.E. OF TAIL PLANE AND FINS
JOHN PALMER
BAG TYPE FUEL TANKS
ROTOL 11 ft. 6 in. DIA. PROPELLERS
ROLLS-ROYCE DART 526 (RDa. 7/2) TURBOPROP OF 2,100 e.h.p.
REARWARD RETRACTING MAIN UNDERCARRIAGE
LEADING EDGE THERMAL DEICING
FUEL AND METHANOL REFUELLING POINTS ON UNDERCARRIAGE STRUT

control through a Flight Director, or fully automatic control. Double slotted flaps are fitted.

SYSTEMS **Cabin Air** Maximum differential cabin pressure is 5.5 lb/sq in. Air pressure is provided by three engine-driven blowers, driven from two port engines and the starboard outer engine. Control is by a Normalair pressure controller operating in conjunction with a minimum pressure altitude selector; by this means, the altitude at which pressurization begins (or ceases on descent) can be varied between sea level and 8,000ft. This is of particular value when operating from airfields whose heights above sea level vary.

Ice Protection With the exception of the powerplant, windscreen, fuel filter and pitot heads, all ice protection can be placed under automatic control of ice detectors by selection of the pilot's master switch. Protection is by electrical heating except on the mainplane leading edges, where a hot-air system is employed.

Hydraulics The main system is operated by three engine-driven pumps, and it serves the undercarriage, the undercarriage doors, nosewheel steering, wheel brakes and flaps (the last-named having four positions). Working pressure is 2,500 to 3,000 lb/sq in. An emergency hydraulic system comprising electric motor, pump and reservoir is provided for use in the event of failure of the main system. The freight-door locks and windscreen wipers are operated by their own self-contained hydraulic systems.

Electrics DC power supply is from four 6kW 28V engine-driven generators supplying an equalizing-line system to ensure load sharing. Distribution is from a three-section split busbar. Rotary inverters supply AC single-phase and three-phase 115V 400 cycles. Engine starting is normally from a ground supply, but internal battery starting can be offered if required.

PAYLOAD ACCOMMODATION **AW.650 Argosy** The freight compartment occupies the full length of the aircraft between the front and rear freight doors. It has a floor 46ft 8in long and 10ft wide, and the minimum height of the compartment is 6ft 8in. The freight floor sill at front and rear is 4ft above the ground, i.e., at truck loading height. Passenger seating capacity (six-abreast) is 71 at 38in pitch; 74 (36in); 77 (34in); and 83 (32in).

The main passenger door is at the rear port side, and an emergency passenger door is fitted at starboard rear. Passenger escape hatches are provided at the fourth and eighth windows on the port and at the fifth and ninth on the starboard sides. Seats, when fitted, are arranged three abreast at both sides of a central gangway. The seats are set at a minimum pitch of 32in, and the seat fixings allow for the pitch to be extended by increments of 2in. The galley, when fitted, occupies the rear starboard corner of the fuselage.

Front and rear freight doors swing open 110 deg and give loading bays 6ft 8in high with a minimum width of 8ft 4in and 8ft 8in at front and rear ends respectively. In the front freight door are a baggage compartment and one toilet. The rear freight door contains another toilet and a baggage or mail compartment.

An upward-retracting step ladder leads from the freight compartment to the crew compartment through a hatch in the crew floor. The crew compartment has stations for first and second pilots, and space provision for a third member of the crew with a seat facing rearwards at the starboard rear of the compartment. This seat can be rotated through 180 deg for take-off. The maximum height of the crew compartment is 5ft 5in, the width 7ft 0in (at floor) and the length from instrument panel to rear bulkhead 10ft 10in. A bay behind the crew compartment, and accessible through a door from the crew compartment, contains air conditioning and miscellaneous electrical equipment.

AW.670 Airbus Basically the vehicle ferry variant, the AW.670 can utilize its large volume for the accommodation of up to 126 passengers. The width of this version's fuselage is 14ft 6in, which permits the accommodation of six cars in two rows, together with 30 passengers on the upper deck.

Britannia

Bristol Aircraft, Ltd., Filton, Bristol

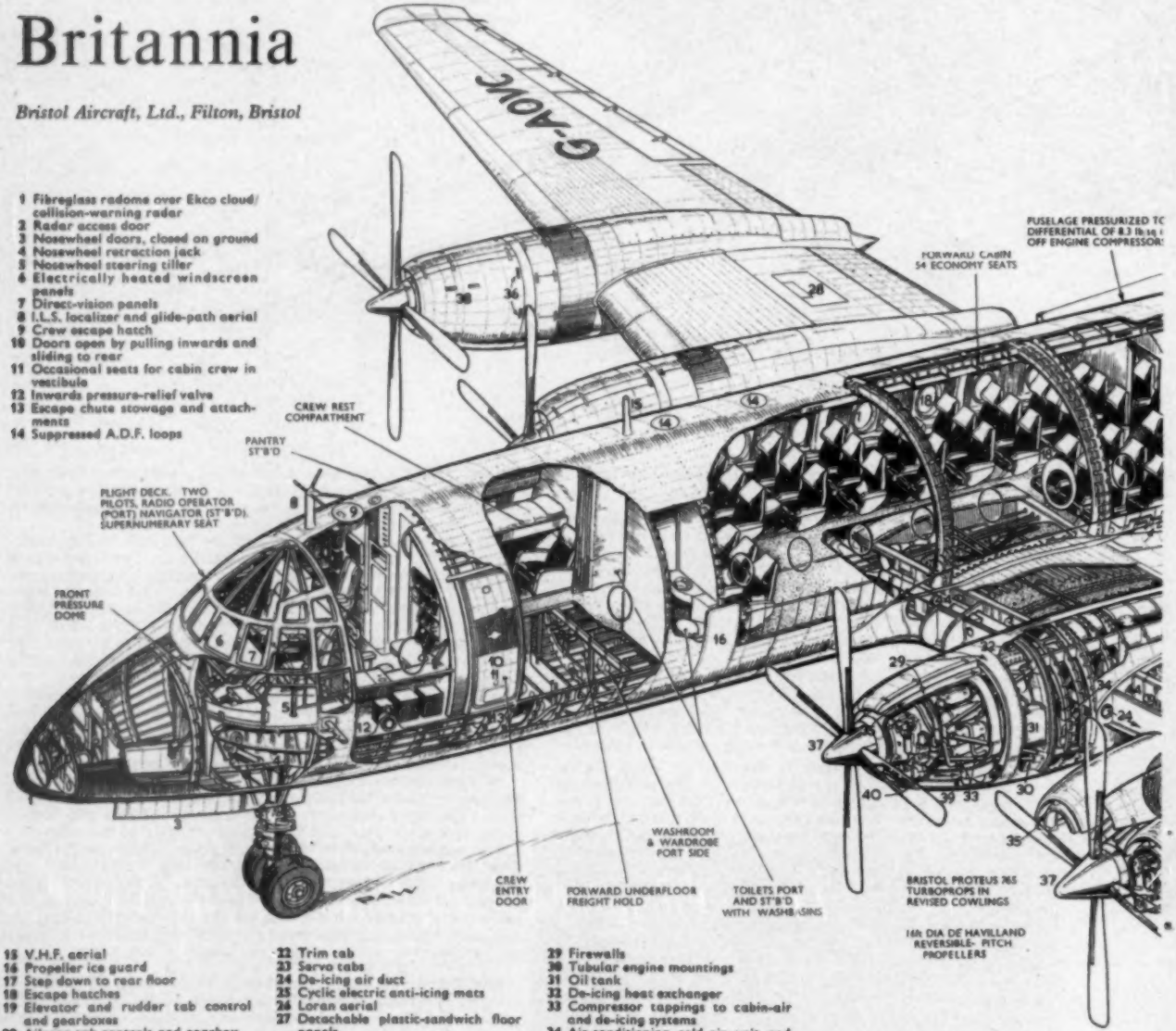
IT is ten years since Bristol decided to develop an engine and an airframe which, combined, would give long-range air transport operations the optimum potential combination of comfort, speed and cost. The result of this decision was the Britannia family of airliners, which emerged initially as the medium-range Britannia 102, fifteen of which were built for B.O.A.C.'s Commonwealth routes, and which entered service in February 1957.

The main variant, which is the subject of the following description, was the 310, the long-range development of the original formula, and the type which is now in production and in regular operation with B.O.A.C., El Al, and C.P.A.L. Bristols are currently engaged upon an improved version of the 310 bearing the designation 320 and incorporating many detail improvements resulting from operating experience with earlier long-range Britannias. Differences between the 310 and 320 series aircraft are mostly of a nature that can be progressively incorporated on the production line, and it seems likely that later deliveries of 310s will be at the weight, tankage, and modification standard of the 320 specification (see next page), which includes all alterations necessary for compliance with American requirements.

Though the air transport industry has undergone many changes since the Britannia was conceived, the aircraft possesses one quality which has a permanent attraction—low operating cost. The Bristol Proteus was matched to the Britannia virtually from the start, and notwithstanding serious icing difficulties during the early part of its operational life—difficulties which have now been mastered—this engine has emerged as the most economical means of providing long-range air transport available today.

But the future of the Britannia is to some extent linked to the airlines' recognition of a need for two basic price levels in the industry; and if this recognition comes within the next two years—which is not unlikely with the introduction of jets a mere four or five months away—the full low-cost advantages of the aircraft will be realized. In the meantime, there exists in production, and with 70,000 hours of airline operating experience behind it, a long-range airliner which is the Western world's sole application of propeller-turbine power to long-haul operations.

COMMERCIAL HISTORY The first order for the Britannia was placed by **B.O.A.C.** in July 1949, for 25 aircraft. The first six of these were to have had Bristol Centaurus piston engines, but in December 1950 this idea was abandoned, and it was decided that all the aircraft should be powered by the Bristol Proteus turboprop. The next order came in June 1955 when **El Al** ordered three long range Britannias (designated 310) and in the following August B.O.A.C. announced that their order had been increased from 25 to 33 aircraft, made up as follows: 15 Britannia 102s, eight Britannia 300s, and ten Britannia 310s. Towards the end of the year the Corporation sold one of its 300-series aircraft to the Ministry of Supply, and ordered one more long-range Britannia 310. Five 300s were subsequently brought up to long-range standard by installing full 310


G-AOVC
FUSELAGE PRESSURIZED TO DIFFERENTIAL OF 8.3 lb sq in OFF ENGINE COMPRESSORS
FORWARD CABIN 54 ECONOMY SEATS
CREW REST COMPARTMENT
PANTRY ST'B'D
FLIGHT DECK. TWO PILOTS, RADIO OPERATOR (PORT) NAVIGATOR (ST'B'D). SUPERNUMERARY SEAT
FRONT PRESSURE DOME
WASHROOM & WARDROBE PORT SIDE
CREW ENTRY DOOR
FORWARD UNDERFLOOR FREIGHT HOLD
TOILETS PORT AND ST'B'D WITH WASHBASINS
BRISTOL PROTEUS 765 TURBOPROPS IN REVISED COWLINGS
16ft DIA DE HAVILLAND REVERSIBLE-PITCH PROPELLERS

1 Fibreglass radome over Ekco cloud/collision-warning radar
2 Radar access door
3 Nosewheel doors, closed on ground
4 Nosewheel retraction jack
5 Nosewheel steering tiller
6 Electrically heated windscreen panels
7 Direct-vision panels
8 I.L.S. localizer and glide-path aerial
9 Crew escape hatch
10 Doors open by pulling inwards and sliding to rear
11 Occasional seats for cabin crew in vestibule
12 Inwards pressure-relief valve
13 Escape chute stowage and attachments
14 Suppressed A.D.F. loops
15 V.H.F. aerial
16 Propeller ice guard
17 Step down to rear floor
18 Escape hatches
19 Elevator and rudder tab control and gearboxes
20 Aileron tab controls and gearbox
21 Bar unit
22 Trim tab
23 Servo tabs
24 De-icing air duct
25 Cyclic electric anti-icing mats
26 Loran aerial
27 Detachable plastic-sandwich floor panels
28 Dinghy stowages
29 Firewalls
30 Tubular engine mountings
31 Oil tank
32 De-icing heat exchanger
33 Compressor tappings to cabin-air and de-icing systems
34 Air-conditioning cold-air unit and cooler

wing tankage, these modified 300s being designated 305s.

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STRUCTURE The fuselage, 12ft in outside diameter, is of constant circular section for 49ft 2½in of the 77ft length which is usable for payload accommodation. Basic airframe material is high-tensile light alloy, and general skin thickness of the fuselage is 18 gauge. The fuselage is stressed for a differential cabin pressure of 8.3 lb/sq in. The cabin floor is designed for an overall loading of 37 lb/sq ft and a local bearing load of 200 lb on any isolated square inch. Two under-floor freight holds are stressed to 75 lb/sq ft. (For details of payload accommodation, see below.)

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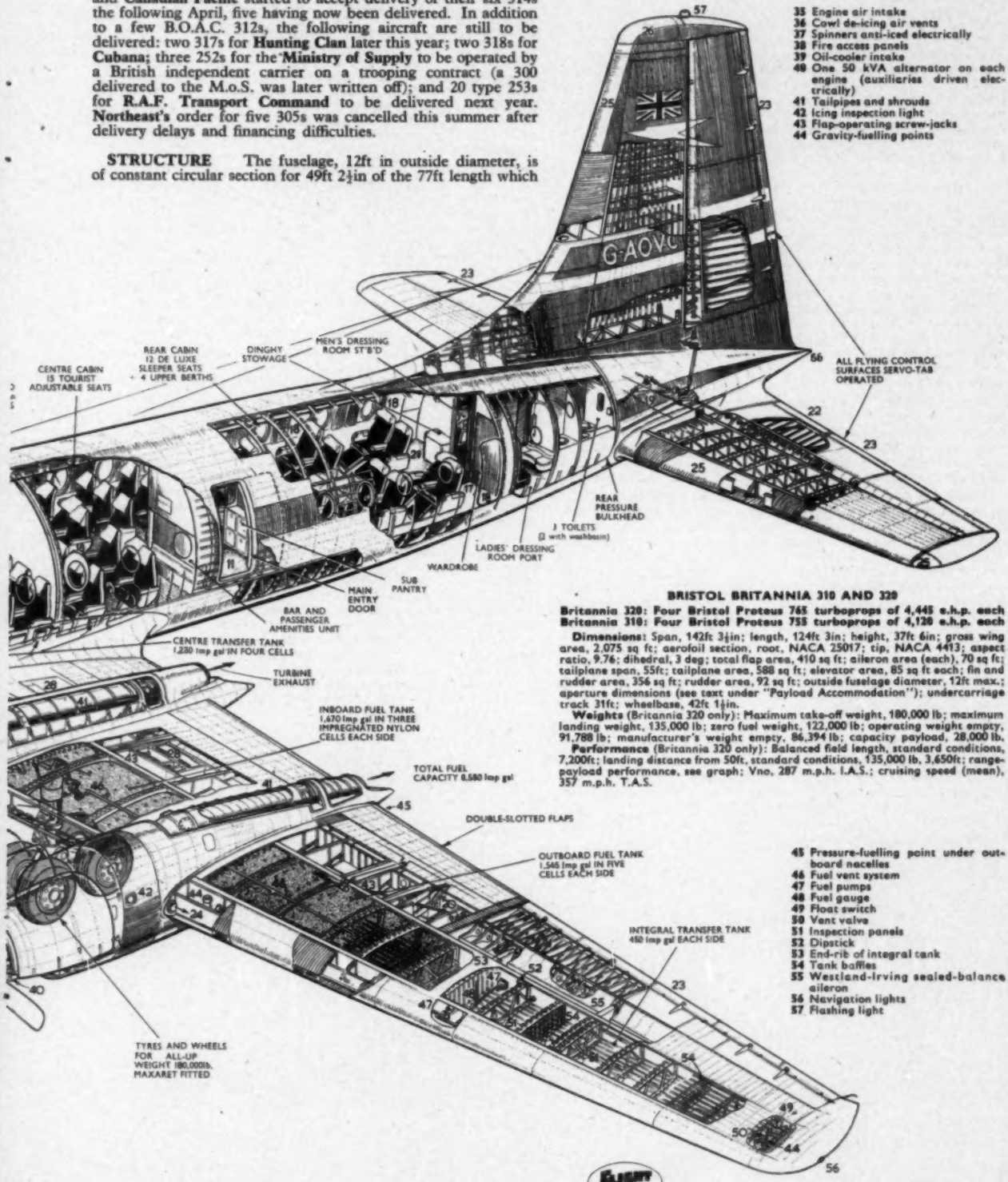
35 Engine air intake
36 Cowl de-icing air vents
37 Spinners anti-iced electrically
38 Fire access panels
39 Oil-cooler intake
40 One 50 kVA alternator on each engine (auxiliaries driven electrically)
41 Tailpipes and shrouds
42 Icing inspection light
43 Flap-operating screw-jacks
44 Gravity-fuelling points
45 Pressure-fuelling point under outboard nacelles
46 Fuel vent system
47 Fuel pumps
48 Fuel gauge
49 Float switch
50 Vent valve
51 Inspection panels
52 Dipstick
53 End-rib of integral tank
54 Tank baffles
55 Westland-Irving sealed-balance aileron
56 Navigation lights
57 Flashing light
G-AOV
CENTRE CABIN 15 TOURIST ADJUSTABLE SEATS
REAR CABIN 12 DE LUXE SLEEPER SEATS + 4 UPPER BERTHS
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BRISTOL BRITANNIA 310 AND 320

Britannia 320: Four Bristol Proteus 765 turboprops of 4,445 e.h.p. each
Britannia 310: Four Bristol Proteus 755 turboprops of 4,120 e.h.p. each

Dimensions: Span, 142ft 3½in; length, 124ft 3in; height, 37ft 6in; gross wing area, 2,075 sq ft; aerofoil section, root, NACA 25017; tip, NACA 4413; aspect ratio, 9.76; dihedral, 3 deg; total flap area, 410 sq ft; aileron area (each), 70 sq ft; tailplane span, 55ft; tailplane area, 588 sq ft; elevator area, 85 sq ft each; fin and rudder area, 356 sq ft; rudder area, 92 sq ft; outside fuselage diameter, 12ft max.; aperture dimensions (see text under "Payload Accommodation"); undercarriage track 31ft; wheelbase, 42ft 1½in.

Weights (Britannia 320 only): Maximum take-off weight, 180,000 lb; maximum landing weight, 135,000 lb; zero fuel weight, 122,000 lb; operating weight empty, 91,788 lb; manufacturer's weight empty, 86,394 lb; capacity payload, 28,000 lb.

Performance (Britannia 320 only): Balanced field length, standard conditions, 7,200ft; landing distance from 50ft, standard conditions, 135,000 lb, 3,650ft; range-payload performance, see graph; Vno, 287 m.p.h. I.A.S.; cruising speed (mean), 357 m.p.h. T.A.S.

Britannia

Bristol Aircraft, Ltd., Filton, Bristol

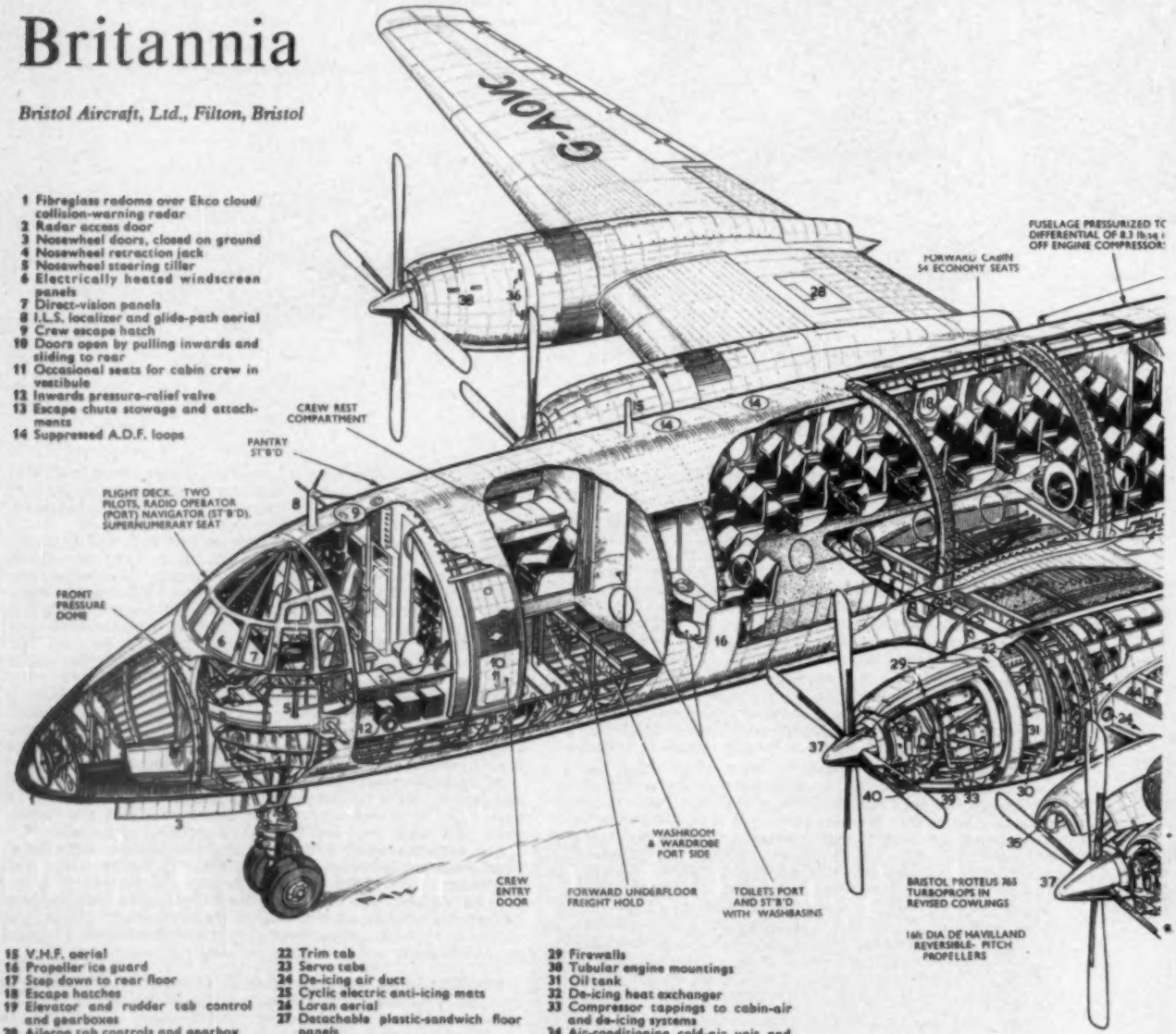
IT is ten years since Bristol decided to develop an engine and an airframe which, combined, would give long-range air transport operations the optimum potential combination of comfort, speed and cost. The result of this decision was the Britannia family of airliners, which emerged initially as the medium-range Britannia 102, fifteen of which were built for B.O.A.C.'s Commonwealth routes, and which entered service in February 1957.

The main variant, which is the subject of the following description, was the 310, the long-range development of the original formula, and the type which is now in production and in regular operation with B.O.A.C., El Al, and C.P.A.L. Bristols are currently engaged upon an improved version of the 310 bearing the designation 320 and incorporating many detail improvements resulting from operating experience with earlier long-range Britannias. Differences between the 310 and 320 series aircraft are mostly of a nature that can be progressively incorporated on the production line, and it seems likely that later deliveries of 310s will be at the weight, tankage, and modification standard of the 320 specification (see next page), which includes all alterations necessary for compliance with American requirements.

Though the air transport industry has undergone many changes since the Britannia was conceived, the aircraft possesses one quality which has a permanent attraction—low operating cost. The Bristol Proteus was matched to the Britannia virtually from the start, and notwithstanding serious icing difficulties during the early part of its operational life—difficulties which have now been mastered—this engine has emerged as the most economical means of providing long-range air transport available today.

But the future of the Britannia is to some extent linked to the airlines' recognition of a need for two basic price levels in the industry; and if this recognition comes within the next two years—which is not unlikely with the introduction of jets a mere four or five months away—the full low-cost advantages of the aircraft will be realized. In the meantime, there exists in production, and with 70,000 hours of airline operating experience behind it, a long-range airliner which is the Western world's sole application of propeller-turbine power to long-haul operations.

COMMERCIAL HISTORY The first order for the Britannia was placed by **B.O.A.C.** in July 1949, for 25 aircraft. The first six of these were to have had Bristol Centaurus piston engines, but in December 1950 this idea was abandoned, and it was decided that all the aircraft should be powered by the Bristol Proteus turboprop. The next order came in June 1955 when **El Al** ordered three long range Britannias (designated 310) and in the following August B.O.A.C. announced that their order had been increased from 25 to 33 aircraft, made up as follows: 15 Britannia 102s, eight Britannia 300s, and ten Britannia 310s. Towards the end of the year the Corporation sold one of its 300-series aircraft to the Ministry of Supply, and ordered one more long-range Britannia 310. Five 300s were subsequently brought up to long-range standard by installing full 310



1 Fibreglass radome over Ekco cloud/collision-warning radar
2 Radar access door
3 Nosewheel doors, closed on ground
4 Nosewheel retraction jack
5 Nosewheel steering tiller
6 Electrically heated windscreen panels
7 Direct-vision panels
8 I.L.S. localizer and glide-path aerial
9 Crew escape hatch
10 Doors open by pulling inwards and sliding to rear
11 Occasional seats for cabin crew in vestibule
12 Inwards pressure-relief valve
13 Escape chute stowage and attachments
14 Suppressed A.D.F. loops
15 V.H.F. aerial
16 Propeller ice guard
17 Step down to rear floor
18 Escape hatches
19 Elevator and rudder tab control and gearboxes
20 Aileron tab controls and gearbox
21 Bar unit
22 Trim tab
23 Servo tabs
24 De-icing air duct
25 Cyclic electric anti-icing mats
26 Loran aerial
27 Detachable plastic-sandwich floor panels
28 Dinghy stowages
29 Firewalls
30 Tubular engine mountings
31 Oil tank
32 De-icing heat exchanger
33 Compressor tappings to cabin-air and de-icing systems
34 Air-conditioning cold-air unit and cooler

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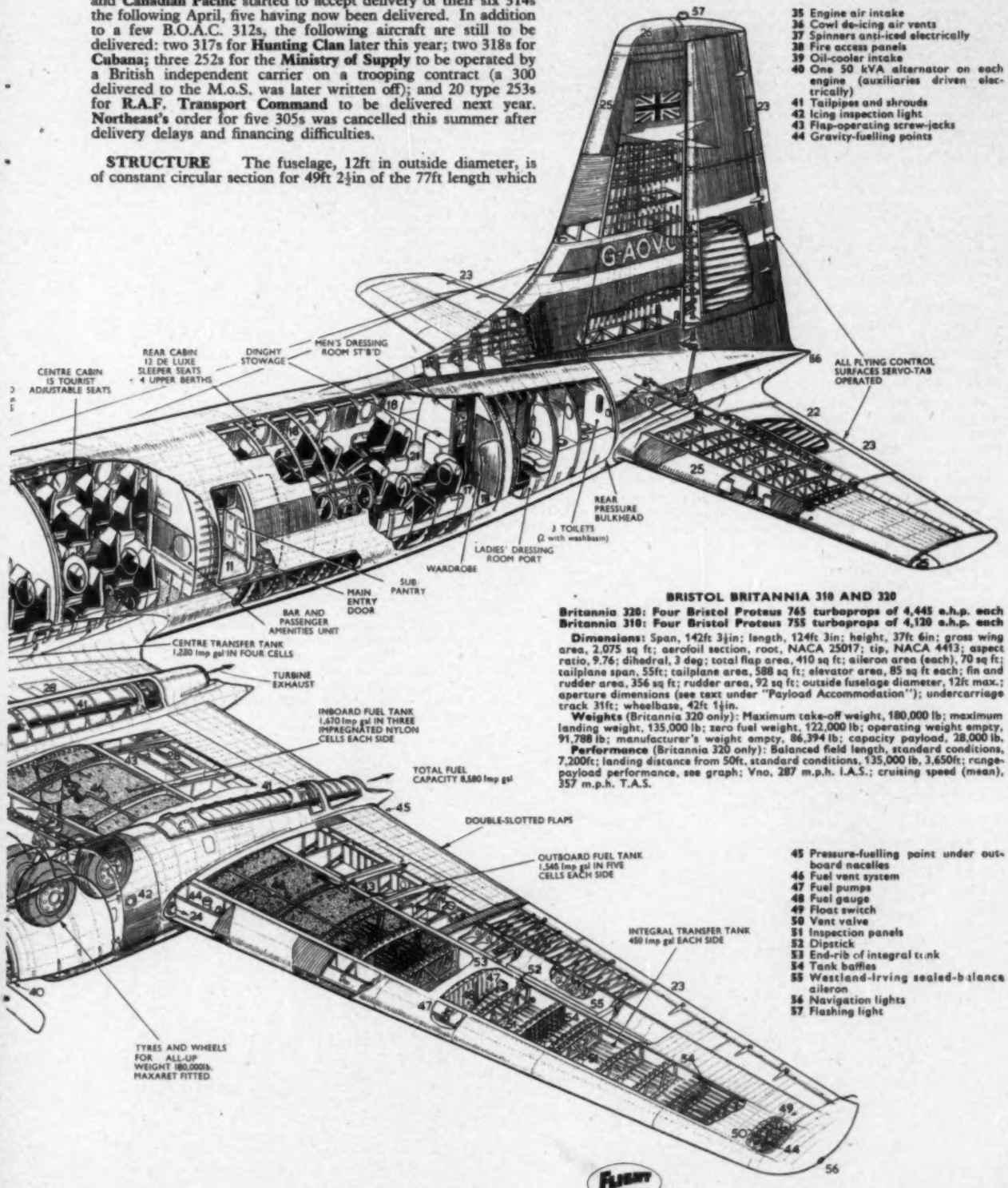
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Britannia . . .

Fin and tailplane are of conventional construction. The main undercarriage, by British Messier, consists of a bogie carrying two pairs of wheels in tandem pivoted to an oleo-pneumatic shock strut hinged at its upper end to the wing box spar and braced by a forward telescopically extending drag strut. Hydraulic retraction is rearwards into the inboard nacelles. Tyre pressure is 140 lb/sq in mainwheels, and 138 lb/sq in nosewheels. Tyres, wheels and brakes are by Dunlop, as are the anti-skid units. Nosewheel steering range is 50 deg each side of neutral, to provide a minimum turning radius of 57½ft (pivot centre to nosewheel). The steering mechanism can be disconnected, to provide for towing purposes a steering angle of 90 deg each side of neutral.

POWERPLANT The Britannia 310 is powered by four Bristol 755 turboprops of 4,120 e.h.p. each, driving de Havilland four-blade propellers. A new development of this engine, described in *Flight* for July 11, is the 760-series Proteus, which offers increased power and lower specific fuel consumption. The Proteus 765 offers 4,445 e.h.p.; and performance figures given at the end of this article are with this engine installed.

SYSTEMS **Fuel System** All fuel is contained within the wing box spar, and is distributed between the outboard integral tanks and the inboard flexible fuel tanks as indicated in the cut-away drawing. Total fuel capacity of the 310 is 8,486 Imp. gal and 8,580 Imp. gal in the Britannia 320 (centre tank 1,230 gal; inboard tanks 1,670 gal; outboard tanks 1,545 gal).

Flying Controls The Britannia has a manually operated system of flying controls. The basic principle of operation takes the form of aerodynamic servo tabs operated through gearboxes and torque tubes from the cockpit. Each control surface carries full-span tabs, and is freely hinged to the airframe. In flight each control surface takes up a position according to the aerodynamic load on its tab.

Cabin Air System Maximum differential pressure is 8.3 lb/sq in, which permits a cabin altitude of 6,000ft at a cruising altitude of 35,000ft. Each engine compressor supplies air to the system, and ventilation is at a minimum rate of 120 lb of air per minute at all altitudes up to 35,000ft. Recirculated air can provide total ventilation of at least 270 lb/min. The hot air supplied by the engines is cooled by an after-cooler and is further cooled for the individual cold air louvres by Godfrey cold air units. Regulation of cabin pressure is fully automatic by Normalair, with manual override. Teddington Controls equipment ensures automatic temperature control.

Electrics Electrical power is provided by four 50kVA Rotax generators, one driven by each engine. They produce outputs of 208, 104 and 65V three-phase alternative currents which are fed into transformer rectifier units to provide 112V and 28V DC supplies. Controlled frequency 115V AC is provided by inverters powered from the 112V DC circuit. Batteries consist of six 24V 25amp-hr units, four of which are connected in series for the 112V circuit and the remaining two in parallel for the 28V circuit.

Hydraulics The Britannia's hydraulic system supplies power for undercarriage operation, nosewheel steering, wheel brakes and control surface locking. Normal working pressure is 3,500 lb/sq in to 4,000 lb/sq in, and supply is from four electrically driven pumps, which are switched off from immediately after take-off until just before landing. A separate emergency system is provided for extension of the undercarriage.

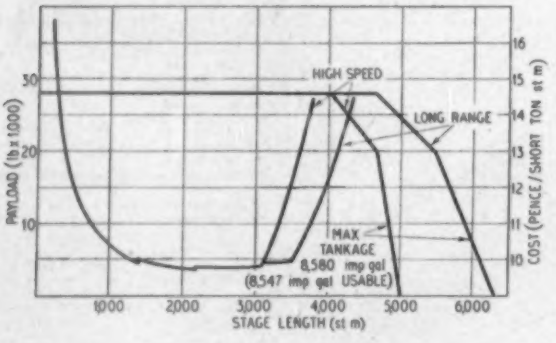
Ice Protection The wing leading edges are de-iced by ram air heated in a heat exchanger supplied by a hot gas tapping from each engine turbine. The tailplane and fin leading edges and elevator horn balances are de-iced by electrically heated mats. The outer walls of the engine intakes are heated by hot gas bled from the turbine casing, diluted with cold ram air. The formation of ice in the bend of the air intake, which was the cause of trouble during the early operational life of the Britannia, is now prevented by tappings from the compressor which energize the boundary layer in this area and prevent the formation of ice. The D.H. propellers are protected from ice formation by electrical elements. The windscreen is electrically protected from ice by Nesa glass.

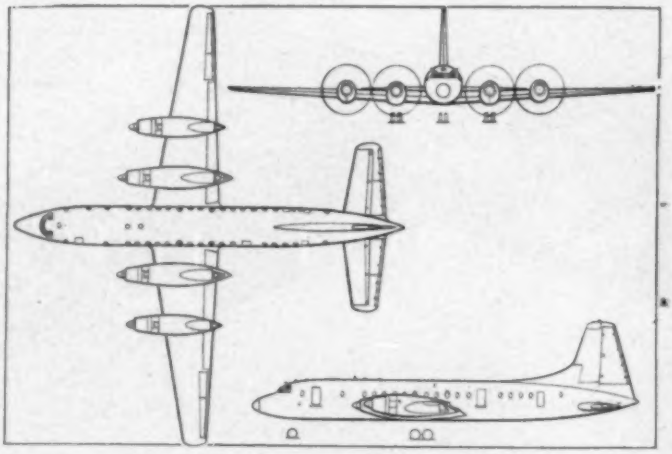
Radio and Radar As with most modern transports, provision is made for the installation of radio and radar equipment to customer's requirements. A typical installation comprises duplicated H.F./V.H.F. transmitter/receivers, with duplicated A.D.F. receivers, I.L.S., D.M.E. (200 mc/s), duplicated V.O.R., Loran, search radar, intercom and public address.

PAYLOAD ACCOMMODATION The Britannia's cabin is 77ft long with a maximum internal width of 11ft 7in, and a headroom of 6ft 8in. Standard seating accommodates 110 passengers, but a typical seating arrangement is for 93 passengers six-abreast (except for three rows five-abreast at the aft end) at 39in pitch. By closing pitch to 34in (economy class), accommodation in the cabins can be increased to a maximum of 133. There are two underfloor freight holds: the forward one, 28ft 1in in length, is of 386 cu ft capacity; the aft freight hold, 30ft 9in in length, has a capacity of 443 cu ft. In addition, an upper baggage compartment of 65 cu ft and a diplomatic mail locker of 16 cu ft give the Britannia a total cargo capacity of 910 cu ft.

The freight-door measurements are, respectively, 52.2in × 30in and 51.2in × 32in. The main passenger entry door measures 70in × 31.5in, and the forward crew and passenger entry door is of similar dimensions. Emergency exits measure a minimum of 24in × 51in. Total usable cabin volume above the floor, excluding the flight deck, is 5,877 cu ft.

Payload-range and cost-range curves for the Britannia 320 (Proteus 765). Assumptions are I.S.A. conditions; 180,000 lb take-off weight; 250 kt I.A.S. for high-speed cruise, 310 kt T.A.S. for long-range cruise; S.B.A.C. cost method.





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- Aircraft is in production for the Royal Canadian Air Force . . . first deliveries, July, 1959.

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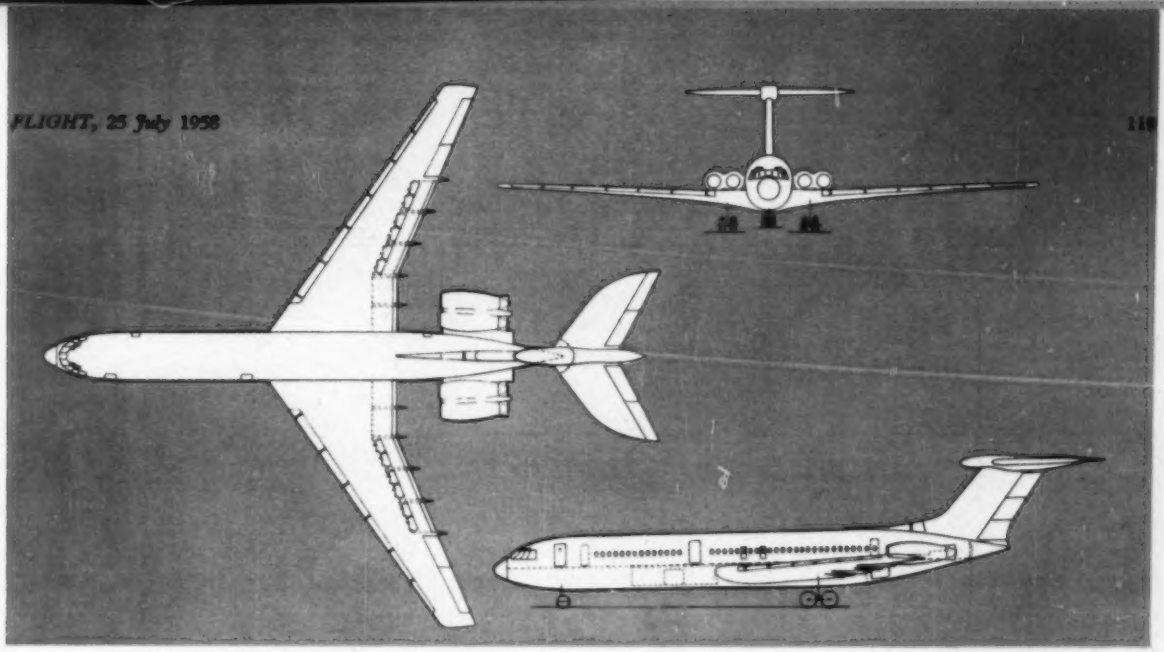


VC.10

Vickers-Armstrongs (Aircraft), Ltd., Weybridge, Surrey

THE VC.10 is in an aircraft category almost entirely of its own. It is, of course, a "big jet" in every sense, but its unique configuration, very wide band of operating ranges and timing for service in 1963 place it in an unusual competitive position, since no other major manufacturer is expected to be selling an entirely new design that will be a direct contemporary. This position has both commercial advantages and disadvantages, but it will presumably leave Vickers with a virtual monopoly of the market among any airlines who, by 1963, have large-capacity jet transport needs still unfulfilled.

Like the Vanguard and Viscount before it, the latest Vickers project has been designed to fulfil a special need of the National Corporations; in this case an airliner for B.O.A.C. that will cruise at about 600 m.p.h. but will also be able to operate on limited-length, high temperature runways such as those found on the Empire routes—a typical example being the stage between Karachi and Singapore. In addition (and this feature represents a major technological step-forward) the VC.10 will have non-stop North Atlantic range and will probably eventually supersede the Corporation's Boeing 707s on this Blue Riband route. The new aircraft will not offer a great increase in speed, in spite of promised additional power from its Rolls-Royce Conway powerplants; Sir George Edwards stated earlier this year that the cruising speed would be improved over the Boeing 707 by only about M=0.02 (about 13 m.p.h.) at its cruising altitude of 40,000ft. The VC.10 may, in fact (as was suggested in *Flight* of January 24) "be the first aircraft ever to make use of additional power to improve runway performance rather than speed." Already Rolls-Royce are prepared to guarantee impressive minimum powers for developed versions of the by-pass Conway; the RCo.12, for example, has a minimum thrust of 17,500 lb and the RCo.15 18,500 lb; both engines may have improved specific fuel consumptions as well.

In January of this year, some eight months after the VC.10 had been first announced (as a new transport for B.O.A.C.) Sir George Edwards, managing director of Vickers-Armstrongs (Aircraft) and Mr. Basil Smallpeice, managing director of the Corporation, signed a contract for 35 VC.10s for the airline with an option on a further 20. The value of the order, without spares, was £60m and was the largest single contract yet placed for any British civil aircraft. The break-even figure was given by Sir George Edwards as "about 70-80." Detail design of jigs, tools, airframe structure and systems has been under way for months past at Weybridge and Hurn, and the scale of work is steadily increasing.

Few details of the aircraft have yet been released (naturally enough, since, at this stage of any project, fairly major changes are more or less frequent) but scale models reveal that the VC.10 is cast in uncommon mould. It has a really clean, swept wing (without fences) and an even more sharply swept tailplane—with a remarkably low aspect ratio—set high up on a large swept fin and rudder; the joint between vertical and horizontal surfaces being faired with a very large streamline acorn of distinctive shape. There is a hint of area rule about the shape of the VC.10. The root wing section shows more camber on the lower than upper surface—a technique similar to that adopted on the DC-8's wing profile to delay the drag rise with a wing of moderate sweep angle.

The new, official Vickers general-arrangement drawing reproduced on this page (while not necessarily representing accurately the aircraft that will fly for the first time in 1961) reveals certain features of the VC.10 that have hitherto been merely speculation. Perhaps the most readily apparent change from early model pictures is the addition of very substantial fairings for the guides to the Fowler flaps which extend along the length of the trailing edge from aileron to aileron. The flaps do not, however, continue across the underside of the centre section, which houses the bogies of the inward-retracting undercarriage.

The control surfaces shown are particularly interesting. The outboard position of the ailerons is not used on either the Boeing 707 or Convair 880, which utilize inboard ailerons for manœuvring at high speeds. But the VC.10 does have the spoilers (six per side) which are to be found on all the U.S. jet trio; and these can presumably be used differentially to assist or to command the aircraft's rate of roll. To improve low-speed and field performance, split-section slats extend along almost the entire length of the leading edge of the wing, and are complementary to the Fowler flaps and the engine position which gives a clean wing. The whole configuration of the VC.10 is aimed towards achieving minimum take-off and landing distances.

It will also be observed that all flying-control surfaces are split: each aileron and elevator into two, and the rudder into three. No tabs are shown, so that it is reasonable to assume that the surfaces are fully powered and possibly operated by twin hydraulic jacks per section: there would thus be a majority rule in a failure case of three out of four control-surface sections on aileron and elevators and two out of three on the rudder. Control forces are likely to be provided by a feel simulator. The tailplane is of the variable-incidence pattern; definition of the moving part of the surface and streamlined fairing is quite clear. The hinge centre-line of the tailplane will be some way aft of the fixed part of the acorn fairing.

More detail than has been previously released is now shown in the fuselage—now of oval section formed from two intersecting radii. Perhaps the most noticeable feature is the position of the passenger entry door halfway along the fuselage on the port side and in front of the wing. A further door in the nose may be for either passenger or crew entry or both and the usual galley service doors are provided on the starboard side. The windows are smaller than those of the Vanguard and there are 40 of them shown on the port side. The positions of the freight holds and loading doors are interesting; the large section aft of the nose-wheel may be a capacious centralized services bay. The pressurized portion of the fuselage extends well aft and includes the structure supporting the four nacelles; some idea of where this runs is given by the dotted line indicating the floor line. The nacelle stubs are clearly of aerodynamic section and are now placed slightly above the centreline of the engines. The latter are disposed exactly in line, and have noise-suppressing nozzles.

VICKERS-ARMSTRONGS VC.10

Four Rolls-Royce Conway by-pass turbojets, each of at least 16,500 lb thrust

Dimensions: Span, 140ft; length overall, 158ft; height, 41ft 2in; gross wing area, 2,800 sq ft; interior width unfurnished, 148in; usable width at cill height, 138½in.

Weights: Gross weight of initial overwater version, 299,000 lb.

Airco D.H.121

The Aircraft Manufacturing Co., Ltd., Hatfield, Herts.

JUST as the Vickers VC.10 sprang from the requirements of B.O.A.C., so the D.H.121 evolved from the needs of B.E.A. At one time, indeed, it was thought that one basic jet transport might fulfil the needs of the two British Corporations. But as the British industry's project design-work progressed it became apparent that the two requirements were completely irreconcilable. Both Corporations required a British jet transport fully capable of meeting the high-subsonic air-transport requirements of the mid-sixties onwards. But there ended the broad similarity between the two Corporations' needs: a jet for B.E.A., which had to be capable of economic operation on stages of less than 1,000 miles was clearly a different design-exercise from the long-hauler. It was, indeed, more in the Viscount-replacement class.

The D.H.121, which after a long political tussle was finally chosen in February 1958, represents a new class of airliner. Short-range air transport is difficult to exploit economically with jet propulsion, because short stages allow less time for the jet's high speed to offset the inherently higher cost per hour (especially as more time is spent low down). Thus the designers of the D.H.121 and its engines have had to "optimize," probably as no designers have been required to do before, all those factors which make for an economical jet airliner—very high payload in proportion to structure and fuel weight, and very high cruising speed for the minimum fuel consumption.

B.E.A. made known their requirements to the British industry in July 1956. The de Havilland Aircraft Company, in common with other manufacturers, had already done considerable project work to meet B.O.A.C.'s requirement (D.H.118); and they now evolved to B.E.A.'s specification the D.H.119, based upon four Rolls-Royce Avon RA.29s—powerplant of the Comet 4. This developed, for political reasons, into the D.H.120 (four RA.29s or RB.140s), aimed at satisfying both Corporations. But this did not suit either B.O.A.C. or B.E.A.; at length B.O.A.C. ordered VC.10s, and de Havilland concentrated on B.E.A.'s requirements.

Thus was born, in May 1957, the D.H.121, which was to compete for B.E.A. and Government favours with the Bristol 200 (page 148) and the Avro 740 project (later dropped when the Hawker Siddeley Group decided to co-operate with Bristol on the 200).

The basic design decision to be taken was the choice and number of engines; B.E.A.'s and de Havilland's preference was for a Rolls-Royce powerplant, and Rolls-Royce were prepared to design and build an engine of whatever size was required. Eventually a triple-engined layout was evolved, with RB.141s—scaled-down by-pass Conway derivatives developing 12,000 lb thrust each. The choice of three engines was the result of reasoning which probably ran as follows: the fewer the engines, the lower the capital and maintenance costs and installed weight—all factors vital to jet economics. Two engines would have been so large—because of engine-out performance requirements—as to outweigh the twin-engine economies of cost and weight. Four engines would have been excessive in an aircraft of this class.

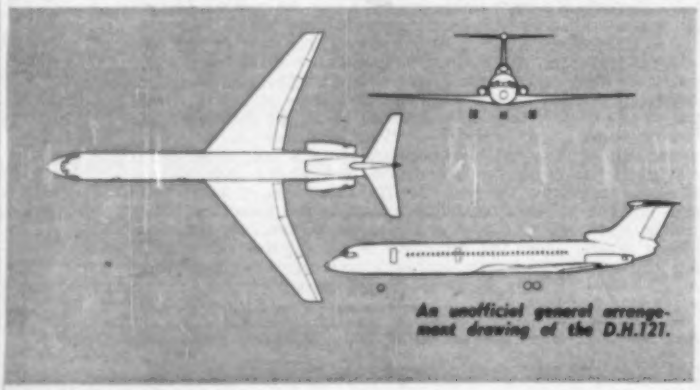
The method of installation was no easy problem: a rear-mounted Caravelle-type arrangement was preferred because of the resultant advantages of a clean wing and cabin quietness; it was also virtually obligatory, since no other practical position exists for a triple-engine scheme. Many layouts were studied; the final arrangement, as shown in the latest artist's impression above, is evidently different from that illustrated at the time of the B.E.A. order last February, when the middle engine was well forward of the fin, instead of beneath, as it is now. This suggests that the engine is now removed by dropping it downwards instead of lifting it up and sideways first, as before; the power-systems bay, previously aft, has presumably been shifted forward. (It is noteworthy that the length of the fuselage forward of the wings has increased considerably since publication of the original drawing—no doubt to improve balance characteristics, which would be further improved by a forward-positioned equipment bay.)

Position of the tailplane, right on top of the swept-back fin, was dictated by the requirements of maximum elevator moment-arm to give the smallest elevator size for the most critical case, i.e., landing; by the need for maximum clearance from reverse-thrust jet blast; and to attain the lowest net structure weight. It is evident from the latest illustration that the middle engine will not, contrary to earlier sketches, be fitted with reversers.

As already noted, the fuselage appears to have increased in length since the early project stages. There are more windows (32 per side) than is demanded by the seating-capacity requirement (up to 100 five-abreast), which suggests that there will be more than one window per seat row. A departure from previous D.H. (Comet) practice, and in conformity with Vickers and Bristol design, is the shape of the windows—vertical, rather than horizontal, ellipses. Fuselage width is likely to be at least 11ft, in order to meet the inevitable airline requirement for six-abreast seating. Cross-section is neither circular nor double-bubble, suggesting two intersecting radii. Nose-shape has changed considerably since the early drawings.

The wing, entirely unobstructed by engines, will have large, highly efficient flaps; no suggestion that slats will be fitted—*à la* VC.10—is apparent. The main undercarriage, set well back on the wing, has inwards-retracting four-wheel bogies.

Airco, the de Havilland-Hunting-Fairey consortium which is designing, developing and building the D.H.121, have issued no data about the aircraft, which is still in the formative stages (entry into service with B.E.A., who have ordered 24 plus an option on 12, will not be until 1963/1964). In the meantime it is possible to predict the following approximate basic data: Gross weight, about 120,000 lb; payload, 20,000 lb plus; max-payload range with reserves, eventually up to 2,000 st. m. (without compromising B.E.A.'s requirement for the optimum 1,000-mile aircraft); cruising speed 600 m.p.h. at 30,000ft (Mach 0.9); take-off thrust, 36,000 lb total from three Rolls-Royce RB.141s. Comet experience suggests a first flight date for the D.H.121 of spring 1961.



An unofficial general arrangement drawing of the D.H.121.

FAIREY

flies

the first

vertical

take-off

Airliner

Adding achievement to achievement,
Fairey Aviation have now built—and flown—
potentially the most important transport aeroplane
in the world, the Fairey Rotodyne.
Carrying 48 passengers or 4¼ tons
of freight it takes off vertically as a helicopter
and having gained height flies forward
as a normal twin-engined airliner.
It is the most adaptable rotary-wing
aircraft in the world and the first to offer
operating economy directly comparable to that
of fixed wing aircraft over ranges of up to 400 miles.
The arrangement within the Rotodyne's
capacious fuselage can readily be adapted to suit
civil or military applications.
Powered by two Napier Eland
propeller-turbines with Fairey Pressure-Jets at the
rotor-tips for take-off and landing.

48 passengers
185 m.p.h. cruising speed
400 miles maximum range

FAIREY
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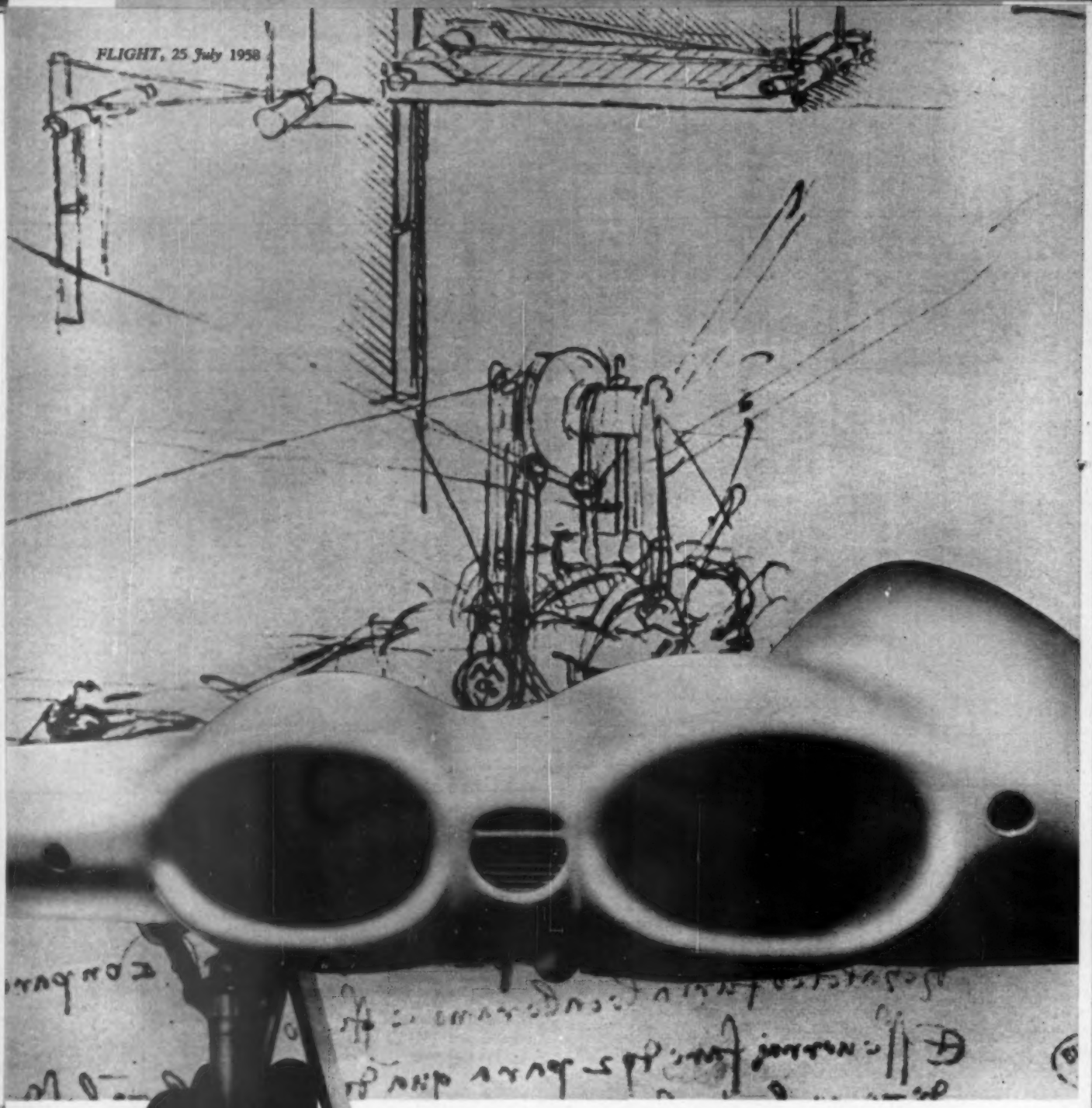

Background illustration from Leonardo da Vinci's notebooks (c.1508) "Design for a flying machine".

THE DEEP PRESSINGS FOR THE ENGINE NACELLES OF THE DE HAVILLAND COMET ARE PRODUCED IN HIDUMINIUM 66 (SPECIAL PROCESSED SHEET)

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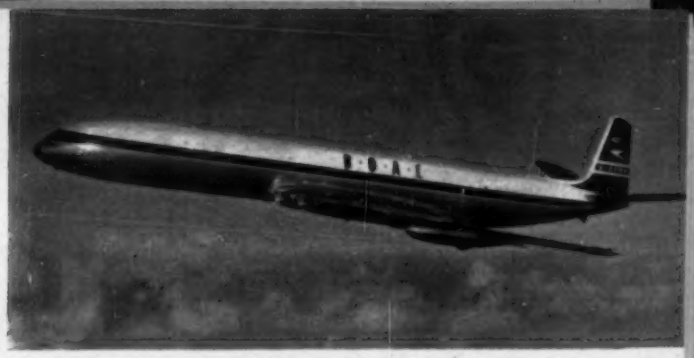
Comet 4

The de Havilland Aircraft Co., Ltd., Hatfield, Herts.



AFTER ten years' continuous design development and testing, the de Havilland Aircraft Company's Comet jet transport, in its Series 4 form, will soon permit the resumption of British commercial jet transport operations.

The first production Comet 4, G-APDA, made its initial flight on April 27 this year, and is undergoing an intensive airworthiness certification programme. Delivery of a production aircraft is expected to be made to the British Overseas Airways Corporation (who have ordered 19 Comet 4s) in September, and it is hoped that B.O.A.C. will inaugurate a token Comet 4 service across the North Atlantic before the end of this year.

The history of the Comet's development is discussed in the section which follows, headed Commercial History. At present offered is a family of jet airliners which can fairly claim to be the most completely tested of any type of aircraft, jet or turboprop, now available to the airlines. The Comet 4, which has been ordered by B.O.A.C. and Aerolineas Argentinas, is the type which will issue from production lines first. It is in a traffic class which is quite distinct: it is a medium capacity airliner (maximum economy-class seating for 80 passengers) with medium to long-range performance; that is to say, the aircraft can carry its first-class capacity payload of 16,800 lb over stage-lengths (with reserves) of up to 3,000 miles. It thus approaches the route capabilities of the big American jets, but without the very large capacity which these aircraft require to be filled.

The response of the Comet's designers to the requirement for *short-haul* jet operations, following the long-haul jet sales of late 1955 and early 1956, finally evolved as the Comet 4B variant, six of which have been ordered by British European Airways. The 4B is designed to apply the Comet's power to lifting payload rather than fuel. The fuselage was extended by 7½ft, to give a total seating capacity of more than 100; and at the same time the wing span was clipped by 7ft 2in and the external fuel tanks omitted. The outcome of this and other changes—including all-round structural strengthening—was an aircraft capable of offering higher speed (20 or 30 m.p.h. more than the Comet 4) and lower seat-mile costs over the shorter stages. Stage-length with capacity payload when operated to a medium-altitude (23,500ft) high-speed technique is of the order of 1,900 st. miles, with full reserves. By using the Comet 4's long-range, high-altitude cruising procedure this stage-length is increased to about 2,550 st.m.

The natural sequel was the 4C, a variant combining the longer fuselage of the 4B with the wing of the 4, to offer the maximum possible exploitation of the Comet in terms of payload and fuel.

COMMERCIAL HISTORY The Comet formula was conceived in 1946, and applied to public service in May 1952. After the suspension of services in 1954, following the two Comet 1 accidents, and applying the new structural knowledge gained as a result, de Havilland concentrated upon the development of the Comet 4. This Rolls-Royce Avon version has twice the power and over twice the capacity of the early Ghost-powered Comet 1. **B.O.A.C.** placed an order for 19 Comet 4s in February 1955. The next order came in July 1956 from **Capital** for 14 4s and 4As but this was subsequently cancelled. In August 1957 **B.E.A.**, faced with the prospect of Caravelle competition, placed an order for six Comet 4Bs to be delivered in 1960. The only other carrier to order Comets is **Aerolineas Argentinas**, delivery of their six Comet 4s—ordered last spring—being spread between early next year and 1960.

STRUCTURE This is the outcome of a programme aimed at two objectives: the establishing of a new anti-fatigue design formula; and the testing of actual components designed according to this formula. The programme has been planned to achieve a useful operational life of not less than 30,000 hours for all Comet 4 variants. (Naturally, the requirements for the achievement of this for the Comet 4B's structure are more severe than they are for the Comet 4, since the shorter-range Comet 4B will spend more of its life flying at lower altitudes at higher speeds, will be pressurized more often and make more landings.)

POWERPLANT All Comet 4 variants are equipped with the same powerplant: four Rolls-Royce Avon RA.29 turbojets of 10,500 lb sea level static thrust each. These engines are already cleared for commercial operations with an overhaul life of 1,000 hours, thanks in part to the large amount of military (flying) experience, and also to the intensive B.O.A.C. Comet 2E flying programme. Two of these aircraft, which are fitted with two Avon RA.29s in place of the outboard RA.9 engines of normal Comet 2s (as operated by R.A.F. Transport Command), were operated by B.O.A.C.'s Comet unit from August 1957. The main part of this programme was devoted to the amassing of RA.29 engine hours, of which a total of 7,440 hr have been completed to date by the two aircraft. One of the two Comet 2Es operated by B.O.A.C. was the property of the Ministry of Supply, who took the aircraft over from B.O.A.C. last May. Subsequently, B.O.A.C. have operated only the one aircraft, the most important item on its programme having been the transatlantic proving trials between London and New York, via Keflavik, Gander and airports on the Eastern seaboard of the U.S. and Canada.

SYSTEMS **Fuel** The total fuel capacity of the Comet 4 is 8,990 (usable) Imp. gal, and of the 4B, 7,890 Imp. gal, disposed as indicated in the cutaway drawing. (Note that the Comet 4B does not have the 440 Imp. gal nacelles or the wing-tip tankage.)

Flying Controls The system is fully power-operated hydraulically. Artificial feel proportional to air speed is provided in the elevator circuit. The flying controls are operated by Lockheed boosters, duplicated mechanically and triplicated hydraulically and with provision—in accordance with American requirements—for ability to trim in the event of power failure.

Cabin Air The air supply is tapped from the compressor of each engine, maximum differential cabin pressure being 8.75 lb/sq in (8,000ft at 45,000ft). There is a duplicated pressure controller by Normalair which is simple to operate, it being necessary merely to preset the altitude at which it is desired to start pressurizing. Temperatures, mass flows, recirculation (the last-named being by injectors and no longer by a fan) are automatically taken care of. Cooling is by D.H. cold-air units.

Ice Protection Anti-icing of wings, tailplane and fin leading-edges and air intakes is by means of hot air tapped from the engine compressors. Icing clearance is for the heaviest icing conditions envisaged by British airworthiness requirements. De-icing and demisting of the windscreens is by glass with transparent electrically heated elements; pitot-heads are heated electrically.

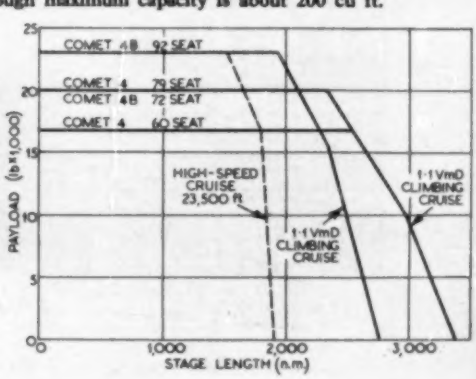
Hydraulics The hydraulic system operates the flying controls, undercarriage, flaps, speed brakes, wheel brakes and nosewheel steering. Normal pressure is 2,500 lb/sq in. The system comprises four separate circuits, colour-coded green, blue, red and yellow.

Electrics Electrical power is supplied by four engine-driven 14kVA alternators, each with a continuous rectified output of 350 amp maintained at 28V. Six 24V, 25 amp-hr batteries are installed. Five of the batteries can be connected in series for internal engine starting.

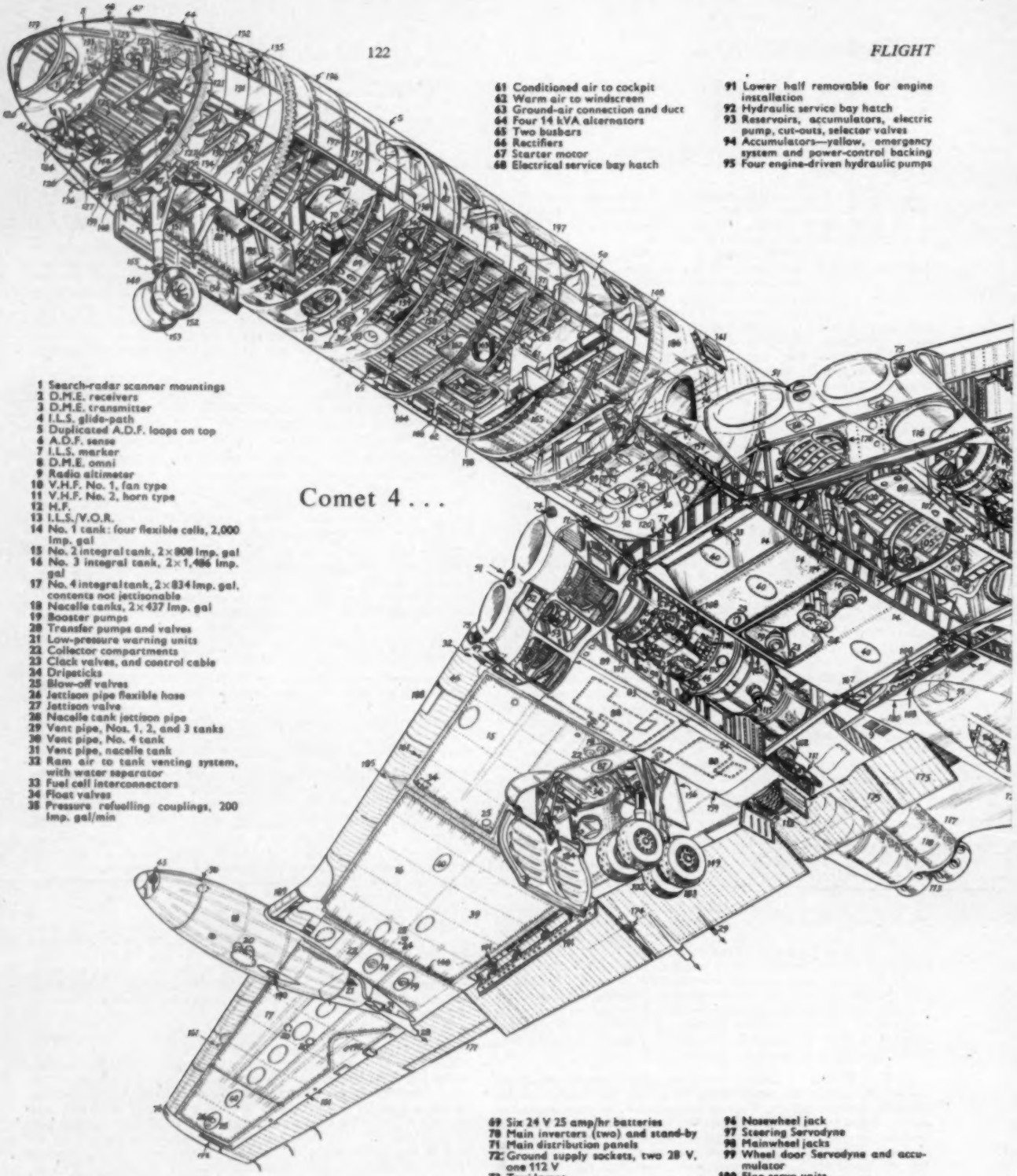
PAYLOAD ACCOMMODATION **Comet 4** *De luxe* class sleeperettes at 56in pitch, four-abreast, 40 seats; first-class, 40in pitch, four-abreast, 56 seats; tourist class, 40in pitch, five-abreast, 71 seats; economy-class, 34in pitch, five-abreast, 81 seats. Numerous mixed-class layouts are possible in the Comet 4; a typical arrangement is 24 first-class passengers forward and 43 tourists aft.

Comet 4B First-class, 37in pitch, four-abreast, 72 seats; tourist class, 34in pitch, five-abreast, 102 seats.

Each Comet version has three pressurized freight-holds, two under the floor and one at the extreme aft end of the cabin. The two under the floor comprise one forward of the centre section having a capacity of 160 cu ft (Comet 4) or 223ft (Comet 4B); and the other, aft of the centre section, having a capacity of 230 cu ft in each version. The third freight hold above the floor at the aft end of the cabin varies in capacity according to the passenger layout provided, though maximum capacity is about 200 cu ft.

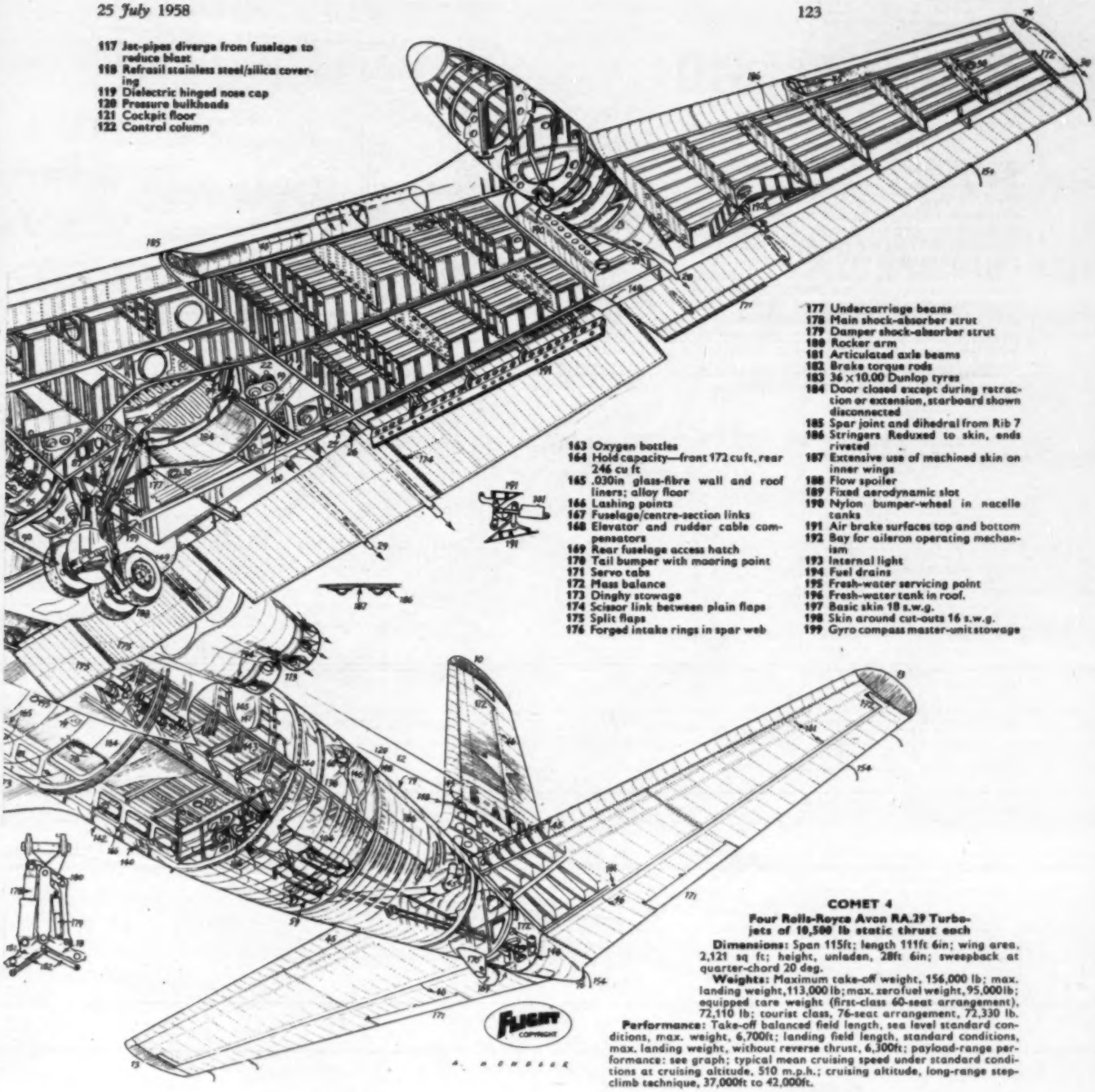


Comet 4 and 4B. Assumptions: 156,000 lb take-off weight; noise suppressors; fuel reserves for 220 n.m. diversion from 1,000ft, climb, cruise and descend again to 1,000ft; ¾ hr stand-off at 15,000ft; 1,200 lb approach fuel.



Comet 4 . . .

1 Search-radar scanner mountings
2 D.M.E. receivers
3 D.M.E. transmitter
4 I.L.S. glide-path
5 Duplicated A.D.F. loops on top
6 A.D.F. sense
7 I.L.S. marker
8 D.M.E. omni
9 Radio altimeter
10 V.H.F. No. 1, fan type
11 V.H.F. No. 2, horn type
12 H.F.
13 I.L.S./V.O.R.
14 No. 1 tank: four flexible cells, 2,000 Imp. gal
15 No. 2 integral tank, 2×908 Imp. gal
16 No. 3 integral tank, 2×1,486 Imp. gal
17 No. 4 integral tank, 2×834 Imp. gal, contents not jettisonable
18 Nacelle tanks, 2×437 Imp. gal
19 Booster pumps
20 Transfer pumps and valves
21 Low-pressure warning units
22 Collector compartments
23 Clack valves, and control cable
24 Dripsticks
25 Blow-off valves
26 Jettison pipe flexible hose
27 Jettison valve
28 Nacelle tank jettison pipe
29 Vent pipe, Nos. 1, 2, and 3 tanks
30 Vent pipe, No. 4 tank
31 Vent pipe, nacelle tank
32 Ram air to tank venting system, with water separator
33 Fuel cell interconnectors
34 Float valves
35 Pressure refuelling couplings, 200 Imp. gal/min
36 Refuelling control panel in wheel bay
37 Refuelling master switch
38 Gravity fillers
39 Fuel capacitor units, amplifiers in electrical bay
40 Tank inspection panels.
41 Outside air-temperature bulbs
42 Ice detector-head and static vent
43 Leading-edge inspection lamp, starboard nacelle tank
44 Captain's spotlamp and detector vane
45 Thermal de-icing ducts, engine bleed
46 Warm-air leaks over surfaces
47 Windscreen electrical and air demisting
48 Hydraulic screen-wipers
49 Flap valve, cold air injection to de-icing system
50 Cabin differential, 8.75 lb per sq in
51 Ram air intake
52 Heat exchanger
53 Cold air unit
54 Silencer and humidifier
55 Pressurization packs
56 Rising duct in centre bulkhead
57 Air to floor-level grilles
58 Recirculation-air venturi
59 Dump valves
60 Inward relief safety valves
61 Conditioned air to cockpit
62 Warm air to windscreen
63 Ground-air connection and duct
64 Four 14 kVA alternators
65 Two busbars
66 Rectifiers
67 Starter motor
68 Electrical service bay hatch
69 Six 24 V 25 amp/hr batteries
70 Main inverters (two) and stand-by
71 Main distribution panels
72 Ground supply sockets, two 28 V, one 112 V
73 Taxi lamps
74 Taxi and turn-off lamps
75 Landing lamps
76 Navigation lights
77 Anti-collision lights
78 Smoke detector units
79 Extinguisher application points
80 Gallery and CO_2 spray points
81 Underfloor ventilating ducts
82 Inertia switches in nose-wheel bay
83 Engine zone No. 1
84 Engine zone No. 2
85 Crash-detection switches
86 Methyl-bromide bottles, zone No. 1
87 Methyl-bromide bottles, zone No. 2
88 "Firewire" system, includes doors
89 Ten temperature-sensitive switches each side
90 Firewalls
91 Lower half removable for engine installation
92 Hydraulic service bay hatch
93 Reservoirs, accumulators, electric pump, cut-outs, selector valves
94 Accumulators—yellow, emergency system and power-control backing
95 Four engine-driven hydraulic pumps
96 Nosewheel jack
97 Steering Servodyne
98 Mainwheel jacks
99 Wheel door Servodyne and accumulator
100 Flap servo units
101 Air brake jacks
102 Maxaret brake-units
103 Aileron servo-unit bay
104 Elevator and rudder servo units
105 Main mounting trunnions
106 Forward hanging points
107 Inlet guide-vanes actuator
108 Shaft drive to alternator
109 Fuel control group
110 Sump and pump group
111 R.-R. thrust-reverser actuator
112 Thrust-reverser blast doors (top and bottom, outer engines only)
113 R.-R. noise-suppressor nozzles
114 Outlet from compressor bleed valves
115 Engine cooling air outlet
116 Forward ducting removed



117 Jet-pipes diverge from fuselage to reduce blast
118 Refrasil stainless steel/silica covering
119 Dielectric hinged nose cap
120 Pressure bulkheads
121 Cockpit floor
122 Control column

163 Oxygen bottles
164 Hold capacity—front 172 cu ft, rear 246 cu ft
165 .030in glass-fibre wall and roof liners; alloy floor
166 Lashing points
167 Fuselage/centre-section links
168 Elevator and rudder cable compensators
169 Rear fuselage access hatch
170 Tail bumper with mooring point
171 Servo tabs
172 Mass balance
173 Dinghy stowage
174 Scissor link between plain flaps
175 Split flaps
176 Forged intake rings in spar web

177 Undercarriage beams
178 Main shock-absorber strut
179 Damper shock-absorber strut
180 Rocker arm
181 Articulated axle beams
182 Brake torque rods
183 36 x 10.00 Dunlop tyres
184 Door closed except during retraction or extension, starboard shown disconnected
185 Spar joint and dihedral from Rib 7
186 Stringers Reduxed to skin, ends rivated
187 Extensive use of machined skin on inner wings
188 Flow spoiler
189 Fixed aerodynamic slot
190 Nylon bumper-wheel in nacelle tanks
191 Air brake surfaces top and bottom
192 Bay for aileron operating mechanism
193 Internal light
194 Fuel drains
195 Fresh-water servicing point
196 Fresh-water tank in roof.
197 Basic skin 18 s.w.g.
198 Skin around cut-outs 16 s.w.g.
199 Gyro compass master-unit stowage

123 Hanging rudder pedals
124 Q-feel unit and pitot
125 Aileron spring strut
126 Autopilot trim servo-motor
127 Flying control primary pulleys; cables onward
128 Cables from pilots' console
129 Captain's chair
130 Navigator and radio officer
131 Table
132 Wall-mounted instruments and oxygen regulators
133 Pilots' flight panel
134 Flight engineer to starboard
135 Radio racks
136 A.S.I. pressure heads
137 Galley box stowage
138 Toilets (two forward, two aft)
139 Waste water tanks
140 Four toilet servicing points
141 Four 26in x 29in emergency hatches
142 Full-size emergency door to starboard
143 Escape-chute stowage

144 Nose equipment-bay hatch
145 Passenger door, inward opening plug-type
146 Coats
147 Large vestibule
148 Production breaks
149 D.H. undercarriage units, forged main members
150 Access to hinge-pins
151 Breaker strut
152 Coupled wheels, 30x9.00 Dunlop tyres
153 Static-discharge whip, nosewheel leg
154 Static dischargers
155 Towing points
156 Doors linked to leg
157 Control cables in under-floor ducts except at centre section
158 Static apertures on skin
159 Jacking points
160 Sockets for datum levelling bar
161 Sockets for rigging sighting rods
162 Freight hold doors on bungee cord

COMET 4

Four Rolls-Royce Avon RA.29 Turbojets of 10,500 lb static thrust each

Dimensions: Span 115ft; length 111ft 6in; wing area, 2,121 sq ft; height, unladen, 28ft 6in; sweepback at quarter-chord 20 deg.

Weights: Maximum take-off weight, 156,000 lb; max. landing weight, 113,000 lb; max. zero fuel weight, 95,000 lb; equipped tare weight (first-class 60-seat arrangement), 72,110 lb; tourist class, 76-seat arrangement, 72,330 lb.

Performance: Take-off balanced field length, sea level standard conditions, max. weight, 6,700ft; landing field length, standard conditions, max. landing weight, without reverse thrust, 6,300ft; payload-range performance: see graph; typical mean cruising speed under standard conditions at cruising altitude, 510 m.p.h.; cruising altitude, long-range step-climb technique, 37,000ft to 42,000ft.

COMET 4B

Four Rolls-Royce Avon RA.29 Turbojets of 10,500 lb static thrust each

Dimensions: Span 107ft 10in; length, 118ft; wing area, 2,066 sq ft; height, 28ft 6in.

Weights: Maximum take-off weight, 156,000 lb; max. landing weight, 118,500 lb; max. zero fuel weight, 102,500 lb; equipped tare weight, first-class 72-seat arrangement, 74,626 lb; tourist class, 102-seat arrangement, 75,100 lb.

Performance: Take-off balanced field length, sea level standard conditions, max. weight, 7,000ft; landing field length, standard conditions, max. landing weight, without reverse thrust, 6,200ft; payload-range performance: see graph; typical mean cruising speed under standard conditions at cruising altitude, 520/545 m.p.h., depending on temperature. Optimum cruising altitude (using high-speed cruising technique), 23,500ft.

COMET 4C

Four Rolls-Royce Avon RA.29 Turbojets of 10,500 lb static thrust each

Dimensions: Span, 115ft; length, 118ft; wing area, 2,121 sq ft; height, 28ft 6in.

Weights: Maximum take-off weight, 156,000 lb; max. landing weight, 118,500 lb; max. zero fuel weight, 102,500 lb; equipped tare weight, first-class 72-seat arrangement, 75,085 lb; tourist class 102-seat arrangement, 75,559 lb.

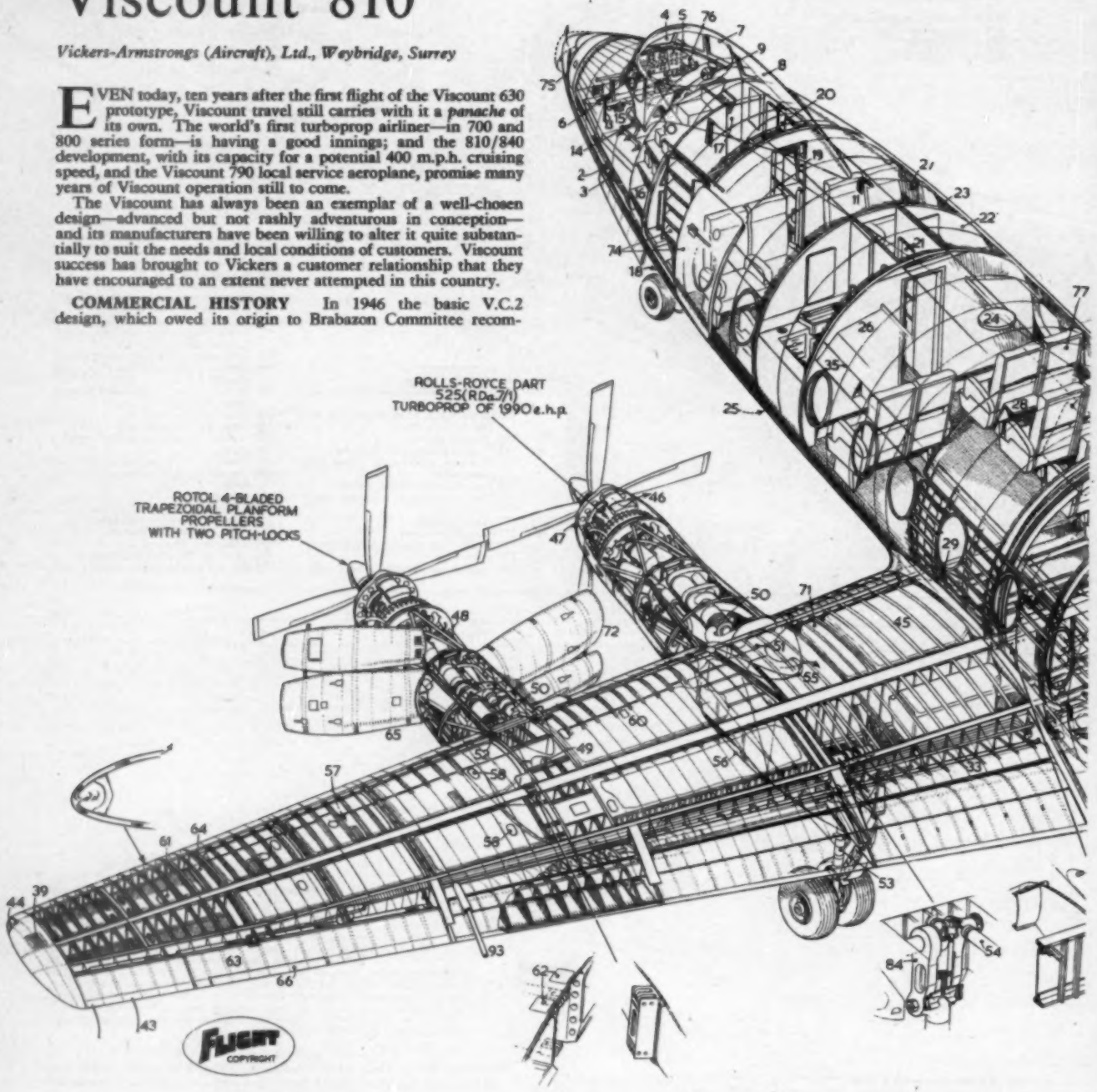
Performance: Take-off balanced field length, sea level standard conditions, max. weight, 6,700ft; landing field length, standard conditions, max. landing weight, without reverse thrust, 6,500ft; payload-range performance: see graph; typical mean cruising speed under standard conditions at cruising altitude, 500 m.p.h.; cruising altitude, long-range step-climb technique, 37,000ft to 42,000ft.

Viscount 810

Vickers-Armstrongs (Aircraft), Ltd., Weybridge, Surrey

EVEN today, ten years after the first flight of the Viscount 630 prototype, Viscount travel still carries with it a *panache* of its own. The world's first turboprop airliner—in 700 and 800 series form—is having a good innings; and the 810/840 development, with its capacity for a potential 400 m.p.h. cruising speed, and the Viscount 790 local service aeroplane, promise many years of Viscount operation still to come.

The Viscount has always been an exemplar of a well-chosen design—advanced but not rashly adventurous in conception—and its manufacturers have been willing to alter it quite substantially to suit the needs and local conditions of customers. Viscount success has brought to Vickers a customer relationship that they have encouraged to an extent never attempted in this country.

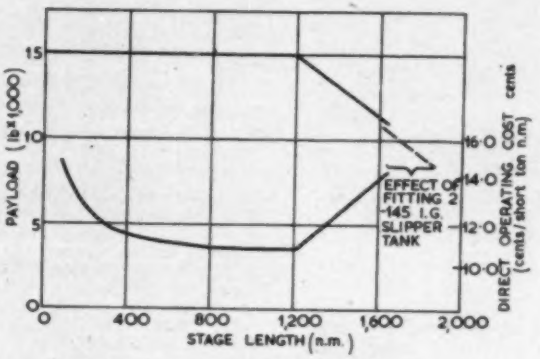

ROLLS-ROYCE DART 525(RDa.7/1) TURBOPROP OF 1990 e.h.p.
ROTOL 4-BLADED TRAPEZOIDAL PLANFORM PROPELLERS WITH TWO PITCH-LOCKS
FLIGHT COPYRIGHT

COMMERCIAL HISTORY In 1946 the basic V.C.2 design, which owed its origin to Brabazon Committee recommendations, was much smaller than the present Viscount and weighed about 30,000 lb. From this design came the Viscount 630 from which in turn was derived the Viscount 700. In the summer of 1948 the Viscount seemed to be doomed. But at this point there began a process of increasing the power of the Rolls-Royce Dart and stretching the airframe—measures which saved the aircraft. A fleet of 20 Viscount 701s was ordered by **B.E.A.** in 1950. The first production 47-seat machines were delivered in early 1953 at a weight of 56,000 lb, the engines being Dart 505s of 1,400 s.h.p. The first commercial scheduled services were inaugurated by B.E.A. in April 1953. All told, sales of 700 series Viscounts have been negotiated with 28 airlines and ten other operators, representing a total of 294 aircraft.

During 1952 **B.E.A.** ordered the first of a new family of the 800 series, then essentially 700Ds with increased payload capacity for optimum economy on the shorter stages. B.E.A.'s fleet of 24 series 802s is now at full strength, having entered service in February 1957. Like the 700D, the 800 is powered by Dart 510s. Gross weight is 63,000 lb. Five other airlines have taken delivery of this 800 version.

In January 1956 B.E.A. ordered 18 more Viscounts to be fitted with Dart 520s and designated 806s. Only a few weeks previously **Continental** had placed an order for 15 Viscount 812s with Dart 525s. Eight further airlines have also ordered 810/840 series Viscounts: **S.A.A.**, 7 (813s) in March 1956; **Lufthansa**, 9 (814s) in May 1956; **P.I.A.**, 3 (815s) in May 1956; **Cubana**, 4 (818s) in June 1956; **V.A.S.P.**, 5 (827s) in May 1957; **Airwork**, 2 (831s) in March 1958; **Ansett/A.N.A.**, 4 (832s) in May 1958;

1 Warm air to cockpit
2 Pitot head
3 Windscreen de-icing fluid connection
4 Nesa-glass heated windscreens
5 Triple wiper and de-icing fluid spray-bars
6 Direct-vision panels
7 Cockpit pressure dome
8 Unpressurized fairing
9 Windscreen de-icing fluid tank
10 Leading-edge ice-inspection lamp
11 V.H.F. No. 1 aerial
12 V.H.F. No. 2 aerial
13 Nosewheel-steering handwheel
14 Aerotherm pilots' seats
15 Rudder-pedal units with toe brakes
16 Main radio crate (remainder in under-floor freight hold)
17 Cockpit door
18 Towing point (scissor link released)
19 Hydraulic-equipment cupboard
20 Hydraulic-fluid tank
21 Ship's library
22 Toilets—port and starboard
23 Public address (Bendix)

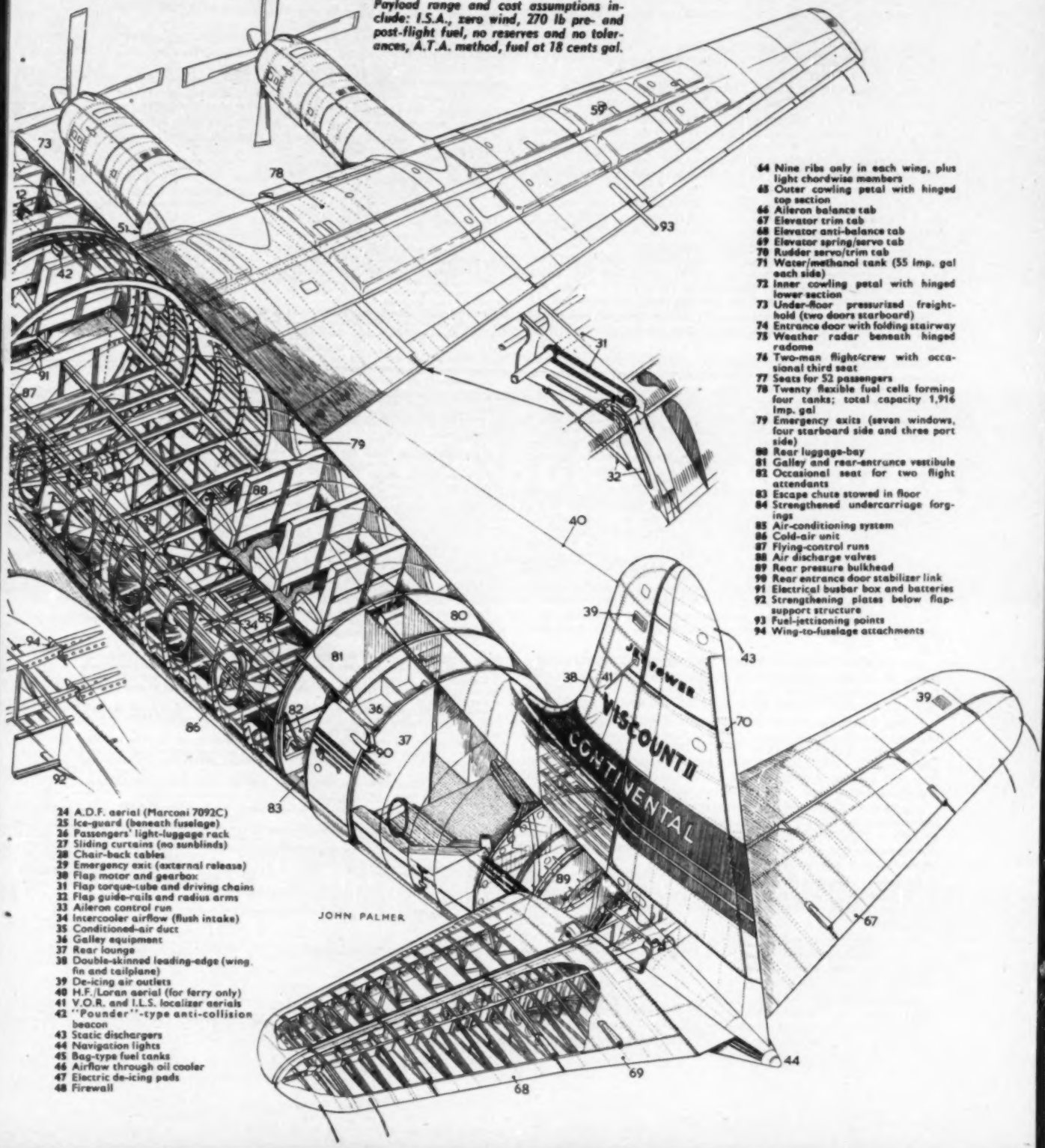


Payload range and cost assumptions include: I.S.A., zero wind, 270 lb pre- and post-flight fuel, no reserves and no tolerances, A.T.A. method, fuel at 18 cents gal.

49 Fire-suppression bottle; three spray rings in nacelle
50 Rocol accessory gearbox on each engine, driving Godfrey cabin blowers, generators, hydraulic pumps and propeller de-icing alternator
51 Cabin blower delivery duct (intake on nacelle flank)
52 Main engine mounting point
53 Vickers 14in-stroke undercarriage
54 Retraction jack
55 Retraction bay
56 Jet-pipes
57 Tank access-panels in bottom surface of wing
58 Covers for Pacitor gauges
59 Float-switch covers
60 Gravity-filling point (pressure refuelling below wing)
61 Landing lamp
62 Access to outer-wing attachment bolts
63 Irving-balanced split ailerons, skew-bar operated

64 Nine ribs only in each wing, plus light chordwise members
65 Outer cowling petal with hinged top section
66 Aileron balance tab
67 Elevator trim tab
68 Elevator anti-balance tab
69 Elevator spring/servo tab
70 Rudder servo/trim tab
71 Water/methanol tank (55 Imp. gal each side)
72 Inner cowling petal with hinged lower section
73 Under-floor pressurized freight-hold (two doors starboard)
74 Entrance door with folding stairway
75 Weather radar beneath hinged radome
76 Two-man flight/crew with occasional third seat
77 Seats for 52 passengers
78 Twenty flexible fuel cells forming four tanks; total capacity 1,916 Imp. gal
79 Emergency exits (seven windows, four starboard side and three port side)
80 Rear luggage-bay
81 Galley and rear-entrance vestibule
82 Occasional seat for two flight attendants
83 Escape chute stowed in floor
84 Strengthened undercarriage forgings
85 Air-conditioning system
86 Cold-air unit
87 Flying-control runs
88 Air discharge valves
89 Rear pressure bulkhead
90 Rear entrance door stabilizer link
91 Electrical busbar box and batteries
92 Strengthening plates below flap-support structure
93 Fuel-jettisoning points
94 Wing-to-fuselage attachments

24 A.D.F. aerial (Marconi 7092C)
25 Ice-guard (beneath fuselage)
26 Passengers' light-luggage rack
27 Sliding curtains (no sunblinds)
28 Chair-back tables
29 Emergency exit (external release)
30 Flap motor and gearbox
31 Flap torque-tube and driving chains
32 Flap guide-rails and radius arms
33 Aileron control run
34 Intercooler airflow (flush intake)
35 Conditioned-air duct
36 Galley equipment
37 Rear lounge
38 Double-skinned leading-edge (wing, fin and tailplane)
39 De-icing air outlets
40 H.F./Loran aerial (for ferry only)
41 V.O.R. and I.L.S. localizer aerials
42 "Pounder"-type anti-collision beacon
43 Static dischargers
44 Navigation lights
45 Bag-type fuel tanks
46 Airflow through oil cooler
47 Electric de-icing pads
48 Firewall



Viscount 810 . . .

Hunting Clan, 3 (833s) in May 1958. Two Greek shipowners also arranged to buy a Viscount 810 each in late 1956. Mr. Basil Mavroleon's order ("Black Lion") has since been cancelled but that for Mr. Niarchos still stands. Deliveries of the 810 have so far been made to Continental, who inaugurated scheduled services on May 28.

STRUCTURE The dimensional envelope of the Viscount 810 is almost identical to that of the 800 but the structure has been stiffened to cater for the higher loads imposed by 400 m.p.h. cruising speeds, and for a higher landing weight of 62,000 lb.

Fuselage The back-to-back channel frames which carry the spar loads have been opened slightly to accommodate wider spar booms. The parallel-motion 64in×36in forward entrance door, incorporating a built-in Airstep, is slightly smaller than the special-purpose 800 series door and there are now two 64in×27in rear doors aft, disposed port and starboard to meet C.A.A. evacuation requirements.

Wing An all-round dimensional increase has been made to the T-section booms which form the compression and tension members of the wing main spar. The wing is built in three sections; an inner and outer wing and a detachable tip. The inner wing is bolted to the fuselage at the main spar by taper bolts, and four additional bolts are used for attachment of the subsidiary spars, the webs of which are attached by shear cleats. Flaps are of the double slotted type and are built in three sections.

Tail Unit The tailplane is set at 15 deg dihedral and comprises a single spar with stiffer webs and slightly thicker skinning than previously used.

Undercarriage Each undercarriage unit, both main and nose, incorporates a single Vickers oleo pneumatic shock absorber on which twin wheels are mounted. The main undercarriage has been stiffened for the 810 and the geometry slightly revised and both main and nose wheels have a slightly longer stroke. Dunlop or Goodyear wheels and anti-skid wheel-brakes are fitted; the 10.75-16.5in mainwheel tyre pressure is 120 lb/sq in and the 7.25-12in nosewheel, 90 lb/sq in. The nosewheel can be steered through 50 deg either way.

POWERPLANT The engines of the Viscount 810 are Rolls-Royce Dart RDa.7/1 (Mk 525) driving four-bladed Rotol constant speed propellers of trapezoidal planform. The Dart 525 develops 1,910 shaft horsepower and is derated for take-off to 1,800 s.h.p. by restriction of the fuel control unit, since the additional power is not required at sea level in I.S.A. conditions. Available in 1960 will be the Dart RDa.11 (Mk 541) of 2,100 s.h.p., which, with detailed changes within the nacelles, will fit into a Viscount 810 to bring it to 840 standard. Both Dart 525 and 541 have a two-stage compressor, seven interconnected straight-flow combustion chambers and a three stage axial-flow turbine.

SYSTEMS **Fuel Systems** The four-tank system comprises 20 Marlite nylon fuel cells with a total capacity of 1,900 Imp. gal—a few gallons less than the 800 series aircraft because of the addition of 55 Imp. gal water methanol tanks in each wing.

Flying Controls These are operated through push/pull rods and levers and—apart from a revised elevator tab—are identical with earlier Viscounts. The Bendix PB 10 autopilot fitted to Continental's V.812s has the servo motors situated directly under the tail surface torque tubes. Viscount 810s are otherwise equipped with a Smith's flight system and an S.E.P.2 autopilot.

Cabin Air Differential pressure is 6.5 lb/sq in, pressure being maintained by three Godfrey cabin blowers supplying air at 75 lb/min at 25,000ft. Provision is made for water separation, Freon refrigeration and Janitrol heating, and Continental's aircraft have an emergency oxygen supply.

De-icing Thermal de-icing utilizing exhaust-heated ram air is directed to the leading edges of mainplanes, tailplane and fin. Propeller blades, spinners and engine air intakes are protected electrically.

Hydraulics The 2,000-2,500 lb/sq in system provides power for the undercarriage, wheel brakes and nosewheel steering. Either Lockheed Mk 9 pump of the pair driven by the inboard engines will pressurize the system.

Radio and Radar Standard equipment includes H.F., V.H.F., glide slope, marker receiver, A.D.F., audio and public address system. AVQ-10 weather radar is fitted to Viscount 812s with the scope in the centre of the engine instrument panel.

Electrics Four 9kW DC generators, one driven by each engine, charge three 24-volt batteries and provide power for the electrical services, which include the flaps, engine starting, feathering and radio and radar supplies.

PAYLOAD ACCOMMODATION Continental's Viscount 812s are arranged as 56-seaters with eight in the forward cabin (four abreast with a central aisle), 44 in 11 rows in the main cabin and four in the rear lounge. The standard version is arranged to carry 52 passengers, with a flight crew of two and a freight hold replacing the rear lounge. Under the cabin floor and forward of the wing is a 250 cu ft freight hold, access being through two 30×42in doors on the starboard side of the aircraft. A further 25 cu ft of storage is available opposite the passengers' door and the upper rear (lounge) hold provides 120 cu ft.

Viscount 790 Earlier this year Vickers announced a version of the Viscount specially adapted to the needs of local service operators. It had a strengthened wing to cater for high speeds at low altitudes, more frequent landings and higher landing weights, a 700-series fuselage with increased passenger accommodation, and a number of features (such as airsteps, propeller brakes and increased battery capacity) to permit the most rapid possible turn-round time on the ground. Built almost entirely from proven Viscount components and systems, the 790 has been described as a "stretched-down" Viscount. Rolls-Royce Dart 506 engines have been adopted for reasons of lower cost, slightly lighter weight and the wealth of background experience that exists with this type.

The aircraft described above, the Viscount 810, is the latest and fastest development of the line, with a strengthened structure to take advantage of higher power from its Rolls-Royce Darts, RDa.7s and later RDa.11s and an all-up weight of 69,000 lb.

VISCOUNT 800

Four Rolls-Royce Dart 510 of 1,680 s.h.p., s.l., I.S.A. each driving four-bladed 10ft diameter Rotol propellers of parallel planform

Dimensions: Span, 93ft 8½in; length, 85ft 8in; height 26ft 9in.

Weights: Maximum take-off, 64,500 lb; max. landing, 58,500 lb; zero fuel, 54,000 lb; max. payload, 13,020 lb.

Performance: Typical cruising speed at 20,000ft, I.S.A., and 56,000 lb weight, 317 m.p.h; total fuel, 1,910 Imp. gal; max. payload range, 790 st.m.*; take off field length, max. T.O. weight, sea level, I.S.A., 5,310ft.

VISCOUNT 810

Four Rolls-Royce Dart 525 of 1,990 s.h.p., s.l., I.S.A. for take-off each driving four-bladed, 10ft diameter Rotol propellers of trapezoidal planform

Dimensions: As above.

Weights: Maximum take-off, 69,000 lb; max. landing, 62,000 lb; zero fuel weight, 57,500 lb; max. payload, 15,054 lb.

Performance: Cruising speed at 20,000ft, I.S.A. and 60,000 lb weight, 365 m.p.h; max. payload range, 985 st.m.*; take-off field length, max. take-off weight, sea level, I.S.A., 5,550ft.

VISCOUNT 840

Four Rolls-Royce Dart 541 of 2,100 s.h.p., s.l., I.S.A. for take-off each driving four-bladed Rotol propellers

Dimensions: As above.

Weights: Maximum take-off, 69,000 lb; max. landing, 62,000 lb; zero fuel weight, 57,500 lb; maximum payload, 14,079 lb.

Performance: Cruising speed at 20,000ft, I.S.A. and 60,000 lb weight, 400 m.p.h.; max. payload range 1,070 st.m.; take-off field length, max. take-off weight, sea level, I.S.A., 5,000ft.

VISCOUNT 700D

Four Rolls-Royce Dart 510 of 1,680 s.h.p., s.l., I.S.A. each driving four-bladed 10ft diameter Rotol propellers

Dimensions: Span, 93ft 8½in; length, 81ft 10in; height 26ft 9in; wing area, 963 sq ft.

Weights: Maximum take-off, 64,500 lb; max. landing, 57,500 lb; zero fuel, 50,168 lb; max. payload, 11,840 lb.

Performance: Typical cruising speed at 20,000ft, I.S.A. and 53,500 lb weight, 325 m.p.h.; total fuel, Imp. gal., 1,967; max. payload range, 1,340 st.m.*; take-off field length, max. take-off weight, sea level and I.S.A., 5,310ft.

VISCOUNT 790

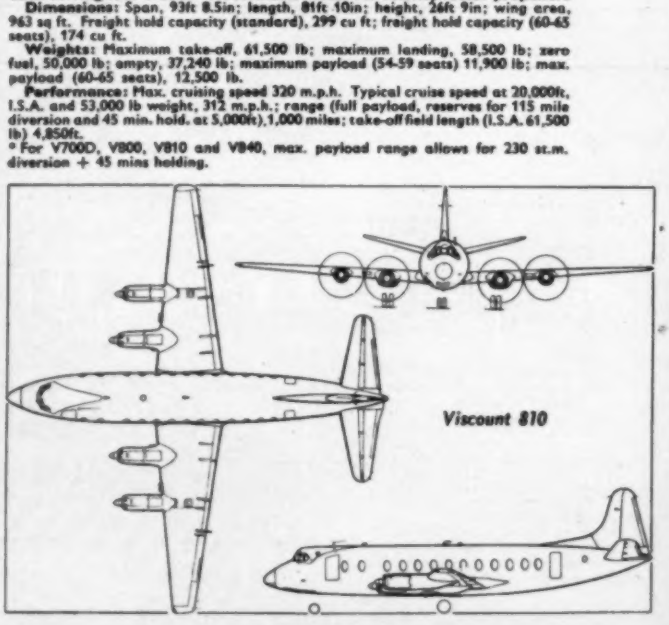
Four Rolls-Royce Dart Mk 506 of 1,400 s.h.p., s.l., I.S.A. for take-off each driving four-bladed 10ft diameter Rotol 140 activity factor propellers

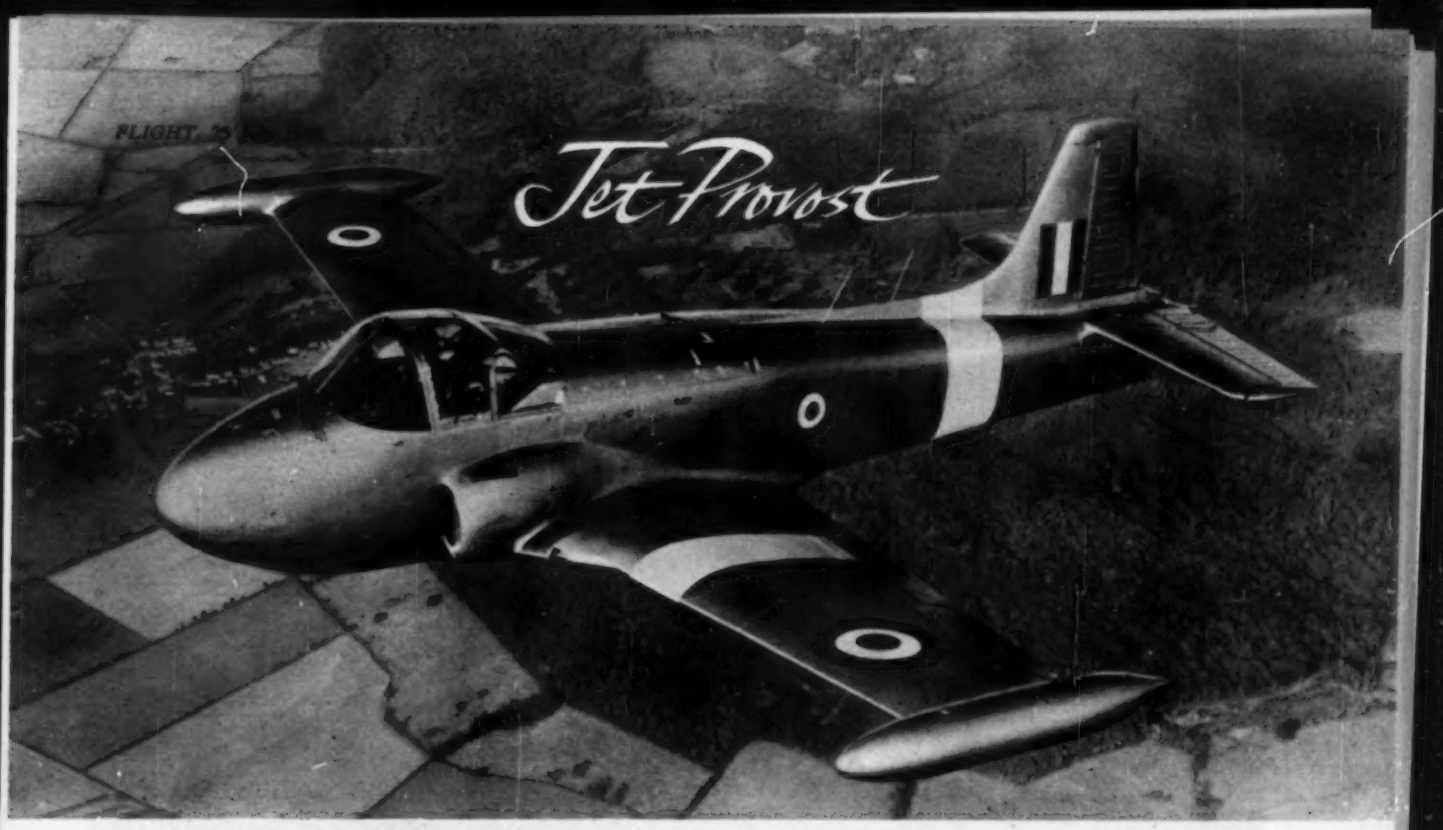
Dimensions: Span, 93ft 8.5in; length, 81ft 10in; height, 26ft 9in; wing area, 963 sq ft. Freight hold capacity (standard), 299 cu ft; freight hold capacity (60-65 seats), 174 cu ft.

Weights: Maximum take-off, 61,500 lb; maximum landing, 58,500 lb; zero fuel, 50,000 lb; empty, 37,240 lb; maximum payload (54-59 seats) 11,900 lb; max. payload (60-65 seats), 12,500 lb.

Performance: Max. cruising speed 320 m.p.h. Typical cruise speed at 20,000ft, I.S.A. and 53,000 lb weight, 312 m.p.h.; range (full payload, reserves for 115 mile diversion and 45 min. hold. at 5,000ft), 1,000 miles; take-off field length (I.S.A. 61,500 lb) 4,850ft.

* For V700D, V800, V810 and V840, max. payload range allows for 230 st.m. diversion + 45 mins holding.





Two years' service with the Royal Air Force has established the Jet Provost ab initio/basic trainer as the best aircraft for its purpose, and the Mk 3 powered by one Armstrong Siddeley Viper Turbo Jet is now in production for the re-equipment of Flying Training Command.

HUNTING AIRCRAFT LIMITED

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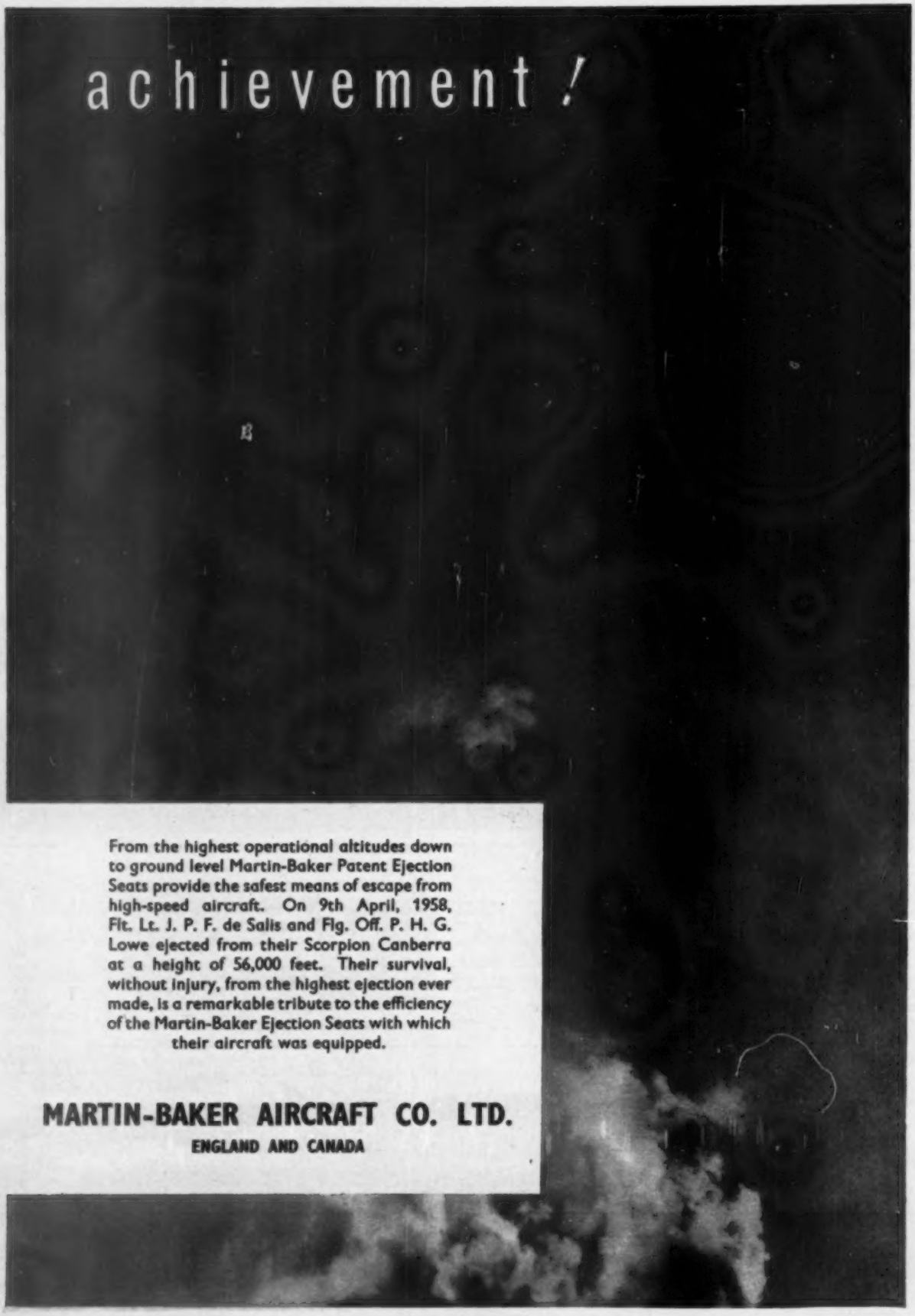
Pembroke

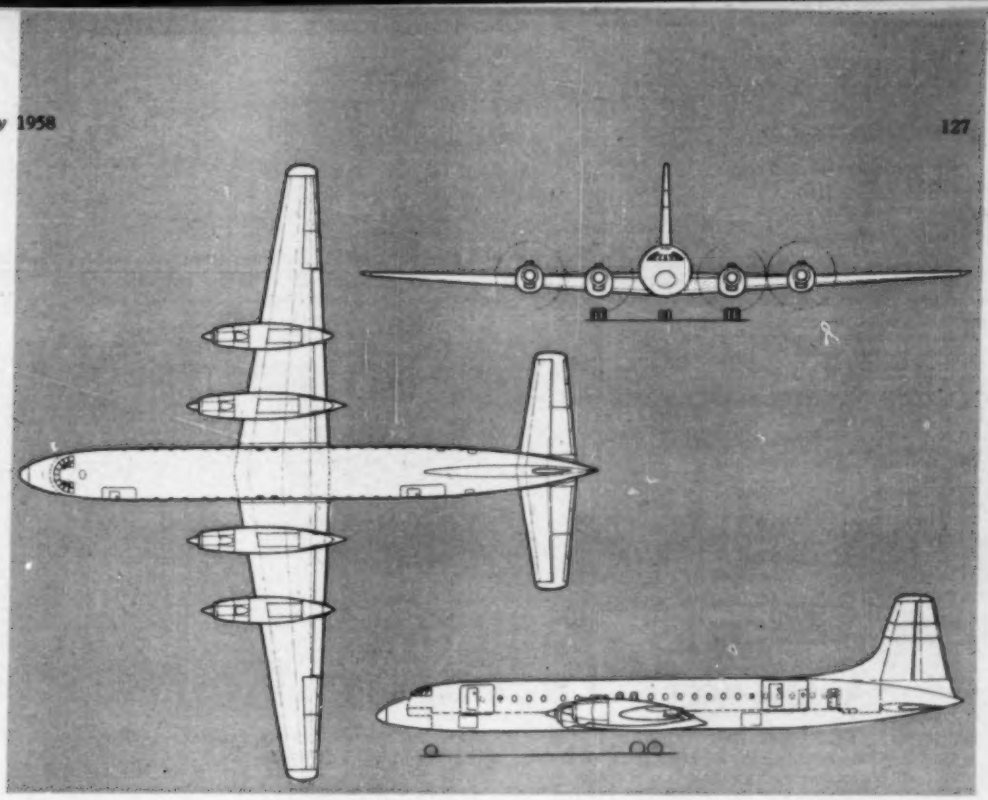
In service with the Air Forces of seven nations, the Pembroke is a versatile general purpose military transport. Passenger seats are quickly removable for conversion to the roles of freight carrying, supply dropping, ambulance, aerial survey or flying classroom.



From the highest operational altitudes down to ground level Martin-Baker Patent Ejection Seats provide the safest means of escape from high-speed aircraft. On 9th April, 1958, Flt. Lt. J. P. F. de Salis and Flg. Off. P. H. G. Lowe ejected from their Scorpion Canberra at a height of 56,000 feet. Their survival, without injury, from the highest ejection ever made, is a remarkable tribute to the efficiency of the Martin-Baker Ejection Seats with which their aircraft was equipped.

MARTIN-BAKER AIRCRAFT CO. LTD.

ENGLAND AND CANADA



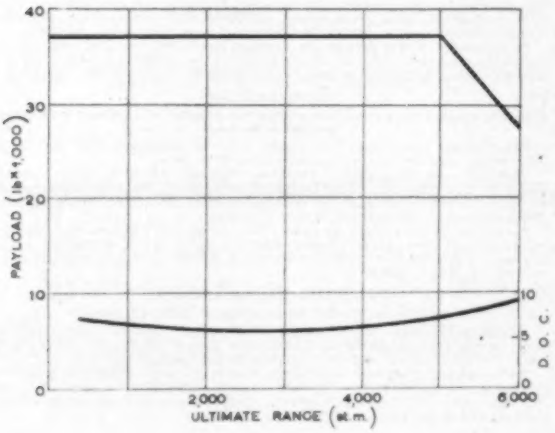
CL-44D

Canadair, Ltd., Division of General Dynamics Corporation, Montreal

IN April 1957 it was announced by Canadair, Ltd., that the Canadian government had decided to buy an aircraft designated CL-44 as the future heavy transport of the R.C.A.F. Air Transport Command (by whom it has been designated CC-106). Originally it was planned as a logical development of the Britannia, but with increased performance resulting from the selection of the Bristol Orion as the powerplant. When development of this engine ceased, Canadair made an evaluation of available alternatives and chose the Rolls-Royce Tyne, with de Havilland 16ft propellers.

With this engine the CL-44D has a wing moved 20in to the rear, a lower basic weight and a performance generally at least as good as that originally planned. Cruising speed will be fractionally lower, but the margin between empty weight and gross weight has been opened out to such an extent that the CL-44D can beat almost every other transport (excepting perhaps the Tu-114) in the matter of payload/range performance. Its ancestry has precluded the incorporation of rear ramp loading, and the interior volume—although as high as 6,400 cu ft, excluding the flight deck—is not great enough to take full advantage of the immense freight payload with cargoes of moderate or low density. Nevertheless, as the accompanying curves indicate, the flexibility and economics of the aircraft promise to be of a wholly outstanding order.

Below is a payload/range and cost curve for the CL-44D in the passenger rôle. Direct operating cost is expressed in cents per 2,000 lb-statute mile, and is calculated according to the 1955 A.T.A. method.



Essentially the structure is that of the Britannia, although it incorporates numerous fundamental changes to conform to North American practice or to suit customer requirements, most of these changes having previously been proven on the CL-28 Argus patrol aircraft (similarly of Britannia ancestry). Among these changes are the adoption of a 3,000 lb/sq in hydraulic system, mechanically driven blowers for cabin pressurization, a completely different electric system with three paralleled 40kVA three-phase, 400 c/s alternators and three 60kVA variable-frequency machines (all engine-driven) and an auxiliary power unit driven by a Blackburn Artouste gas turbine to supply air for engine starting, ground or emergency electricity and ground air conditioning. Moreover, the wing structure has been revised to provide integral tankage for a greatly increased volume of fuel (81,200 lb compared with 68,376 lb for a Britannia 310).

Substantial detail redesign has been effected to the fuselage to incorporate the latest techniques. Overall, the CL-44D is about 13ft longer than a Britannia 310, but the usable interior is no less than 21ft longer, as well as one inch wider. As a result it is possible to seat up to 171 passengers. For freight operations a cargo floor stressed for isolated loads of 300 lb/sq in can be incorporated, and hydraulically operated doors can be provided on the port side with widths of 7ft 9in (forward) and 10ft.

At present the R.C.A.F. order stands at eight aircraft. The first is scheduled to fly in October 1959 (two months earlier than originally planned) and deliveries are to start in the same year. For commercial operations, Canadair are marketing three self-explanatory airliner variants named Canadair Liner, Canadair Freighter and Canadair Freightliner. A full C.A.A./A.R.B. certificate is to be obtained for services to start in 1960.

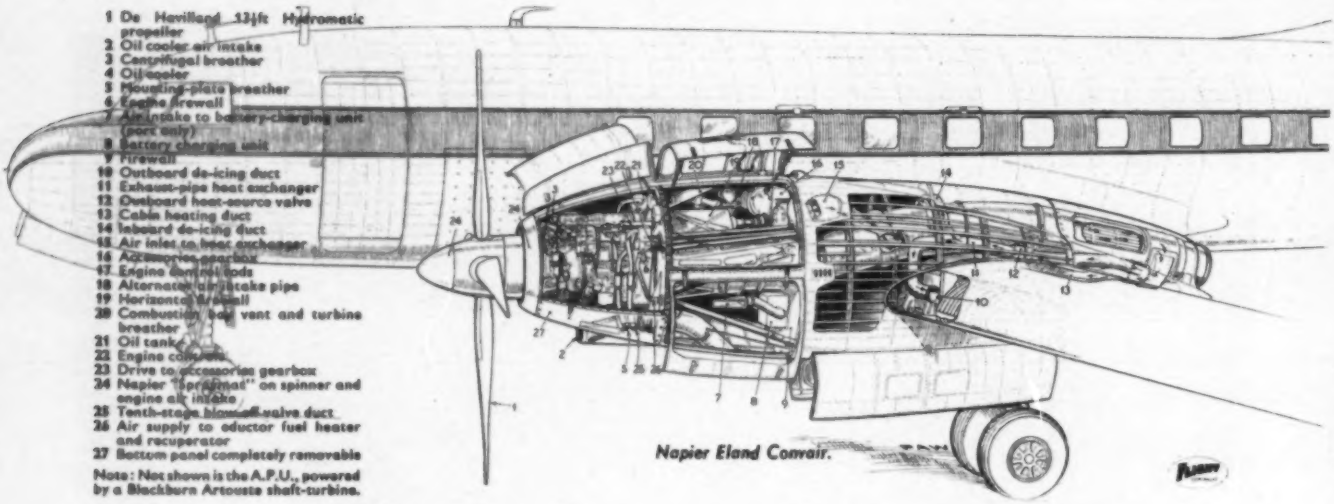
CANADAIR CL-44D

Four Rolls-Royce Tyne 500-series turboprops of 5,500 e.h.p.

Dimensions: Span, 142ft 3¼in; length, 136ft 9in; height, 38ft 11in; gross wing area, 2,075 sq ft; track, 31ft; wheelbase, 49ft 11.4in.

Weights: Basic operating, 98,373 lb with passenger furnishing; maximum fuel, 81,200 lb; maximum payload, see curve for passenger version, 69,500 lb for cargo version; gross weight, 205,000 lb; max. landing, 160,000 lb; zero-fuel, 155,000 lb.

Performance: Balanced field length (I.S.A., sea level, 205,000 lb), 7,250ft; cruising speed, 320 to 325 kt (368 to 375 m.p.h.); approach speed, at 160,000 lb, 122 kt.


1 De Havilland 13½ft Hydromatic propeller
2 Oil cooler air intake
3 Centrifugal breather
4 Oil cooler
5 Mounting-plate breather
6 Engine firewall
7 Air intake to battery-charging unit (port only)
8 Battery charging unit
9 Firewall
10 Outboard de-icing duct
11 Exhaust-pipe heat exchanger
12 Outboard heat-source valve
13 Cabin heating duct
14 Inboard de-icing duct
15 Air inlet to heat exchanger
16 Accessories gearbox
17 Engine control rods
18 Alternator air intake pipe
19 Horizontal firewall
20 Combustion bay vent and turbine breather
21 Oil tank
22 Engine controls
23 Drive to accessories gearbox
24 Napier "Spraymat" on spinner and engine air intake
25 Tenth-stage blow-off valve duct
26 Air supply to eductor fuel heater and recuperator
27 Bottom panel completely removable
Note: Not shown is the A.P.U., powered by a Blackburn Artouste shaft-turbine.

Napier Eland Convair.

Convair Turboprop Conversions

NAPIER ELAND CONVAIR

SINCE Napier decided, early in 1955, to convert a Convair 340 piston-engined airliner to turboprop power, interest in the general idea of turboprop-powered Convairs has quickened.

Napier remain the most prominent contenders, with a first order from REAL of Brazil for their conversion scheme, and a firm order for the Canadair 540 (the R.C.A.F. have ordered ten, designated CL-66). Powerplants will be supplied from England. The engine is the Eland NEI.6 of 3,500 e.h.p. at 12,500 r.p.m.

Napier's first Eland-Convair has been undergoing certification tests in California since the end of 1957; a second aircraft—a 440—is being converted by PacAero of Santa Monica. The C.A.A.'s tests are now, state Napier, over 90 per cent complete.

The Canadair 540, or CL-66, is virtually the same Eland conversion, except that the powerplant is matched with a completely new production CV-440 airframe. (Canadair, like Convair, are part of the General Dynamics Corporation.)

The engineering conversion was fully described in *Flight* for Jan. 20, 1956. Briefly, minimum possible changes to the airframe, apart from the powerplant (i.e., nacelle and firewall), have been made. These airframe changes, all of which are non-structural, are: (1) cockpit controls and instruments; (2) engine control runs; (3) kerosine fuel tank booster pumps and collector boxes.

The conversion can be made in four to five weeks at a cost of approximately $400,000, excluding the resale value of the Pratt and Whitney R-2800 piston-engines and associated equipment.

The Eland conversion achieves, in general, the following: (1) An increase in total power of about 2,200 s.h.p.; (2) An increase in maximum permissible take-off weight from 47,000 lb (CV-340) to 53,200 lb. The increased weight makes it possible to carry the maximum payload of 12,880 lb (compared with 12,700 lb of the 340) for 750 s.m. stage length, with normal fuel reserves, compared with 140 miles for the piston-engined Convair. (For capabilities of the CV-440 conversion, see Canadair 540 data); (3) An increase in cruising speed of about 50 m.p.h.

ALLISON-CONVAIR 340/440 CONVERSION

In the spring of this year Allison Division of General Motors Corporation revealed *their* plans for converting Convair 340s and 440s to the power of the Model 501-D13 turboprop—the powerplant of the Lockheed Electra.

An important contribution to the Allison conversion scheme was made by the two military Convair 340s (YC-131s) which Convair converted in 1955 to the power of two Allison T56s—military forerunner of the Model 501-D13. In addition, the old Allison Turboliner of 1950 (Convair 240 with T38s) is now flying with Model 501-D13s.

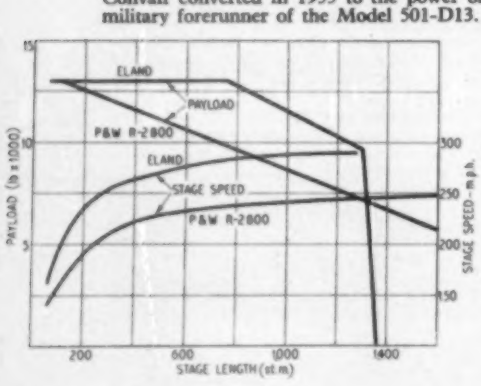
The Allison scheme for the conversion of Convair 340s and 440s involves rather more structural airframe changes than does the Eland conversion. Apart from the nacelle and local wing structure, the following changes are made: (1) Rework of the fin and tailplane to utilize the full take-off power potential, 3,750 e.h.p. of the 501-D13. This rework includes a new vertical fin spar, a 1ft fin-tip extension; a new rudder of larger chord and area, and with larger tabs; increased span of the tailplane by 20in extensions on each side; increased-area elevators with new tabs. (2) Rearrangement of cockpit controls and instruments.

As with the Eland conversion, "minimum change" is otherwise the feature of the Allison conversion.

The Allison conversion costs approximately $450,000, not counting the resale value of the displaced engines and propellers, which Allison estimate at $75,000-$100,000.

The Allison Convair conversion produces, in general, the following results: (1) An increase in total power of about 2,700 s.h.p., for a net increase in weight of 438 lb; (2) Increased maximum take-off weight to 53,200 lb, giving a maximum payload of 12,840 lb (340 conversion) or 12,070 lb (440 conversion). Full payloads can be carried for 725 s.m. with fuel reserves by virtue of the increased max. take-off weight. (3) Increased cruising speed, claimed to be of the order of 80 m.p.h.

The crux of Allison's economic argument for the Allison-Convair is that, while operating cost remains "in the same range," fleet revenue-earning capacity is increased by 25 per cent (because of a 25 per cent higher block speed) for half the capital investment required for a fleet of new turboprop transports.



Payload, range and speed curves for the Eland-powered CV-340.

NAPIER ELAND-CONVAIR 340

Two Napier Eland NEI.6 turboprops of 3,500 e.h.p. each
(For data on the CV-440 conversion refer to Canadair 540)

Dimensions: Span, 105ft 4in; length, 79ft 2in (81ft 6in with radar); height, 28ft 1½in; wing area, 920 sq ft.

Weights: Basic empty operating weight, 31,961 lb; max. payload, space-limited, 44 passengers, freight and baggage, 12,880 lb; fuel tankage with max. payload, 9,359 lb; max. gross weight, 53,200 lb; max. fuel tankage, 11,664 lb; max. structural landing weight, 50,670 lb; max. zero fuel weight, 47,000 lb.

Performance: C.A.R. field length, standard conditions, sea level, max. weight, 4,600ft; landing field length at max. landing weight, 3,700ft; payload-range performance, see graph; typical cruising speed, at 40,000 lb and 20,000ft, 320 m.p.h.

CANADAIR 540

Canadair-built Convair 440 powered by two Napier NEI.6 Eland turboprops of 3,500 e.h.p. each

Dimensions: Span, 105ft 4in; length, 81ft 6in; wheelbase, 26ft 2in; track, 25ft; height, 28ft 5in; propeller/fuselage clearance, 14in.

Weights and Capacities: Maximum take-off, 53,200 lb; max. landing, 50,670 lb; max. zero fuel, 47,000 lb; fuel capacity, 1,698 Imp. gal; max. payload, 13,800 lb; seating capacity, 48-54 seats (four-abreast, 38in pitch); freight capacity, 100 cu ft forward, 200 cu ft aft, 78 cu ft underfloor.

Performance (Standard conditions): Max. range, 2 hr fuel reserve, 1,550 s.m.; range with 48 passengers, 2 hr reserves, 835 st.m.; cruising speed, 325 m.p.h.; cruising altitude, 20,000ft; take-off field length, 4,700ft; landing field length (max. landing weight), 4,330ft.

ALLISON-CONVAIR 340/440

Two Allison 501-D13 turboprops of 3,750 e.h.p. each

Weights: Maximum take-off weight, 53,200 lb; max. landing weight, 50,670 lb; max. zero fuel weight, 47,000 lb; standard fuel weight (1,440 Imp. gal), 11,590 lb; max. fuel weight (1,731 gal with optional extra tankage), 13,930 lb.

Performance (Standard conditions): Maximum range, 3,200 lb fuel reserve, 1,280 s.m.; range with max. 12,840 lb payload, 3,200 lb fuel reserve, 725 s.m.; cruising speed, 350 m.p.h. at 40,000 lb, 20,000ft; take-off field length, 4,500ft; landing field length (max. landing weight), 5,180ft.

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Vanguard

Vickers-Armstrongs (Aircraft), Ltd., Weybridge, Surrey

THE Vanguard caters for the most hotly contested of all airliner markets. As this special issue of *Flight* shows, no fewer than six other types are competing for orders from the operators of medium-haul airline networks. Every operator has different requirements and local conditions, but the majority concur on a set of basic operational requirements. It is to meet them that Vickers designed the Vanguard, putting into it all they and Rolls-Royce (whose Tyne turboprop was conceived specially for the aircraft) have learned from the Viscount.

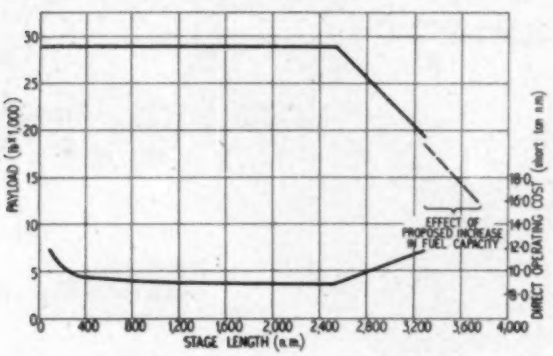
These requirements may be summarized as follows: (1) low seat-mile costs over stage-lengths as low as 200 miles; (2) the ability to carry full payload and fuel reserves on stages of up to 3,000 miles, thus offering one basic vehicle for a route system with widely varying stages; (3) large payload capacity to exploit most economically the rising traffic volume in the years ahead (the theory being that larger transport units are the best way of handling increased traffic); (4) high speed, and a design engineered for fast turn-round at the terminal; (5) moderate airport demands and reasonable noise (the Vanguard is likely to be as quiet as the Britannia); (6) economics which are not too sensitive to the air traffic control delays that may be experienced in the congested air of the sixties; (7) ability to carry a large proportion of capacity payload in off-peak passenger periods, in order to maintain high utilization. This means, in other words, big freight hold volume. The Vanguard has exceptional freight hold volume; indeed, it might fairly be termed a mixed-traffic airliner. Airlines have been used to developing their freight business in the past by carrying it on passenger services, and the Vanguard is intended to be the tool for the continuance and development of this practice until such time as big all-freight machines can be filled; (8) structure, systems, engineering, instrumentation, cockpit layout and payload accommodation conforming with the best modern practice.

Vickers firmly believe that the Vanguard offers all these things, a confidence which is apparent from the production organization which has now been built up. Already six Vanguards are visible on the Weybridge line, and the first aircraft is due to fly next November. Altogether, six aircraft will be used for trials and certification tests, and first deliveries of their 20 Vanguards will be made to B.E.A. in the spring of 1960, followed by deliveries to Trans-Canada Airlines (who have also ordered 20) in the autumn of that year.

COMMERCIAL HISTORY In October 1955, just before the turbojet buying spree moved under way, **B.E.A.** placed an order for 20 Vanguard 951s.

In January 1957, after "one of the most exhaustive analyses ever undertaken," **Trans-Canada Air Lines** placed an order for 20 aircraft and parts worth £23.9m, with an option on a further four aircraft. Modifications to the structure, increasing the payload to 25,000 lb (later to 29,000 lb) and allowing full cruising power to be used at lower altitudes than originally envisaged, was made at T.C.A.'s request. Deliveries of the 951 to B.E.A. will begin in March 1960, and of the 952 to T.C.A. later in the same year; all the latter should be delivered in time for their 1961 summer schedules.

These new payload range and cost curves for the Vanguard assume I.S.A., en route conditions, zero wind. Allowance of 570 lb fuel is made for pre-take-off, landing and taxi requirements, but no account is taken of reserves. Costs to A.T.A. method with fuel at 18 cents per Imp. gal.



STRUCTURE The Vanguard's structure is the embodiment of both safe-life and fail-safe philosophies; in other words, its design is intended for long fatigue life, but with multiple load paths throughout the structure to ensure that even if a fatigue crack does appear the result will not be catastrophic failure.

The Vanguard's wing in particular demonstrates these modern principles. It consists of a torsion box with three shear webs; in the event of failure of one web the remainder can deal with the loads. Wing structure comprises these shear webs with integrally stiffened panels (55 in all and milled from 12ft-29ft long dural planks). Fuel tanks are integral.

The Vanguard's fuselage, in order to provide large freight capacity, is of the double-bubble type. The windows are large, 26in by 19in vertical ellipses, similar to those of the Viscount. There are six main doors, four giving access to the cabin and two to the freight holds. All open outwards. The main entrance door measures 72in by 41in, and is on the forward port side. A second passenger door, also measuring 72in by 41in, is at the aft end of the cabin on the port side. Both doors incorporate built-in hydraulically operated folding passenger steps. Opposite each door is a 64in by 26in emergency exit. There are two other doors into the cabin, both for pantry service, which can be employed for emergency use. The freight hold doors—on the starboard side—are 65in by 46in.

The undercarriage is of Vickers design. Each main gear carries twin wheels fitted with Dunlop tyres, brakes and anti-skid units. Tyre pressure for the main wheels is 104 lb/sq in, and for the nosewheel 85 lb/sq in.

POWERPLANT The engines are four Rolls-Royce Tyne 500-series turboprops, specially designed for the Vanguard. Each drives a 14½ft de Havilland four-bladed constant speed propeller fitted with overspeed pitch locks and automatic phase synchronizing, and incorporating auto-feathering, feathering and reversing. Testing of the Tyne began in April 1955, and to date more than 5,000 hours have been accumulated on the test bed (and in the air, by one engine fitted to an Avro Lincoln). At present two Ambassadors are being fitted by Rolls-Royce with Tynes. One of these (due to fly soon) is being used by Rolls-Royce for general Tyne development flying; the other Ambassador, which is due to fly next month, will be used by B.E.A. for simulated airline service. The aim is to mass about 10,000 Tyne flying hours with these aircraft, the Lincoln and production Vanguards before the engine starts scheduled service with B.E.A. in 1960.

Three development stages of the Tyne are foreseen. Initial production will be the Tyne 1. Take-off power of this version will be 4,500 s.h.p., specific cruising fuel consumption will be 0.405 lb/hr/e.h.p. The Tyne 2, due to appear in 1961, will offer a take-off power of 5,030 s.h.p. and a specific cruising fuel consumption of 0.388 lb/hr/e.h.p. By 1963 the Tyne 3 should be in service, with a take-off rating of the order of 5,500 s.h.p., and with a specific cruising fuel consumption which will, no doubt, be an improvement on its predecessor.

SYSTEMS **Fuel System** As the cutaway drawing shows, there are four integral tanks within the wings. Each of the inner tanks has a capacity of 1,880 Imp. gal; each outer tank has about 670 Imp. gal capacity, giving a total fuel capacity of 5,100 Imp. gal. Mass-flow fuel measuring equipment is standard, and fuel heating is continuous to prevent icing. A single socket in the port wing is available for pressure refuelling at 600 gal/min at 50 lb/sq in. Gravity fillers are available also. All tanks are equipped with Pacitor type gauges and under-wing fuel magnetic level indicators for ground visual checks.

Flying Controls The control surfaces are manually operated through push-pull rods. Spring tabs are fitted to each surface.

Cabin Air Differential cabin pressure is 6.5 lb/sq in. Each inboard Tyne accessory gearbox drives a Godfrey blower; full pressure can be maintained with either blower. A Godfrey cold-

Vanguard . . .

air unit is mounted forward of the front freight hold. (For extreme temperatures, electric heaters or Freon refrigerating systems can be incorporated). Air is introduced into the cabin through the ceiling, and is extracted through louvres in the wall skirting. A radiant wall heating system is also incorporated. Normal cabin air rate-of-change is 20 times per hour.

Ice Protection Wing leading edges are de-iced thermally by ram air which is passed through heat exchangers and heated by exhaust gases tapped from the engine tailpipes. Leading edges of the fin and tailplane are protected by Napier Spraymat electrically heated elements. Triplex gold film (or Nesa glass) protects the windscreens electrically. Propellers, nose cowlings and spinners are also protected electrically.

Hydraulics Lockheed hydraulic pumps are driven from the Tyne accessory gearboxes. Hydraulic power at 3,000 lb/sq in operates the undercarriage, flaps, brakes, steering, windscreen wiper, parking and built-in passenger steps.

Electrics Power is supplied by six variable-frequency A.C. alternators, four of which are coupled to transformer/rectifier units, each of these having an output of 500 amp 28 V DC for the main electrical system. In addition, these alternators supply power for their respective nose cowl, propeller and spinner de-icing systems. Voltage control is by means of carbon pile regulators, and storage batteries are carried under the floor. Two 28 V DC inverters provide 400 c/s three-phase 200 V AC supplies for instruments, autopilot and electronics.

Radio and Radar Provision is made for the following: weather radar, A.D.F., V.H.F., I.L.S./V.O.R., Decca, H.F., Tacan, radio altimeter and transponders.

PAYLOAD ACCOMMODATION The Vanguard's cabin can accommodate six-abreast seating with a capacity of up to 139 passengers in maximum economy-class layout. Normal first-class seating is 97. Maximum internal diameter is 10ft 7in; headroom is 7ft 2.5in. Fixed toilet accommodation is provided in the plane of the propellers; otherwise, galley amenities, wardrobes and bulk-

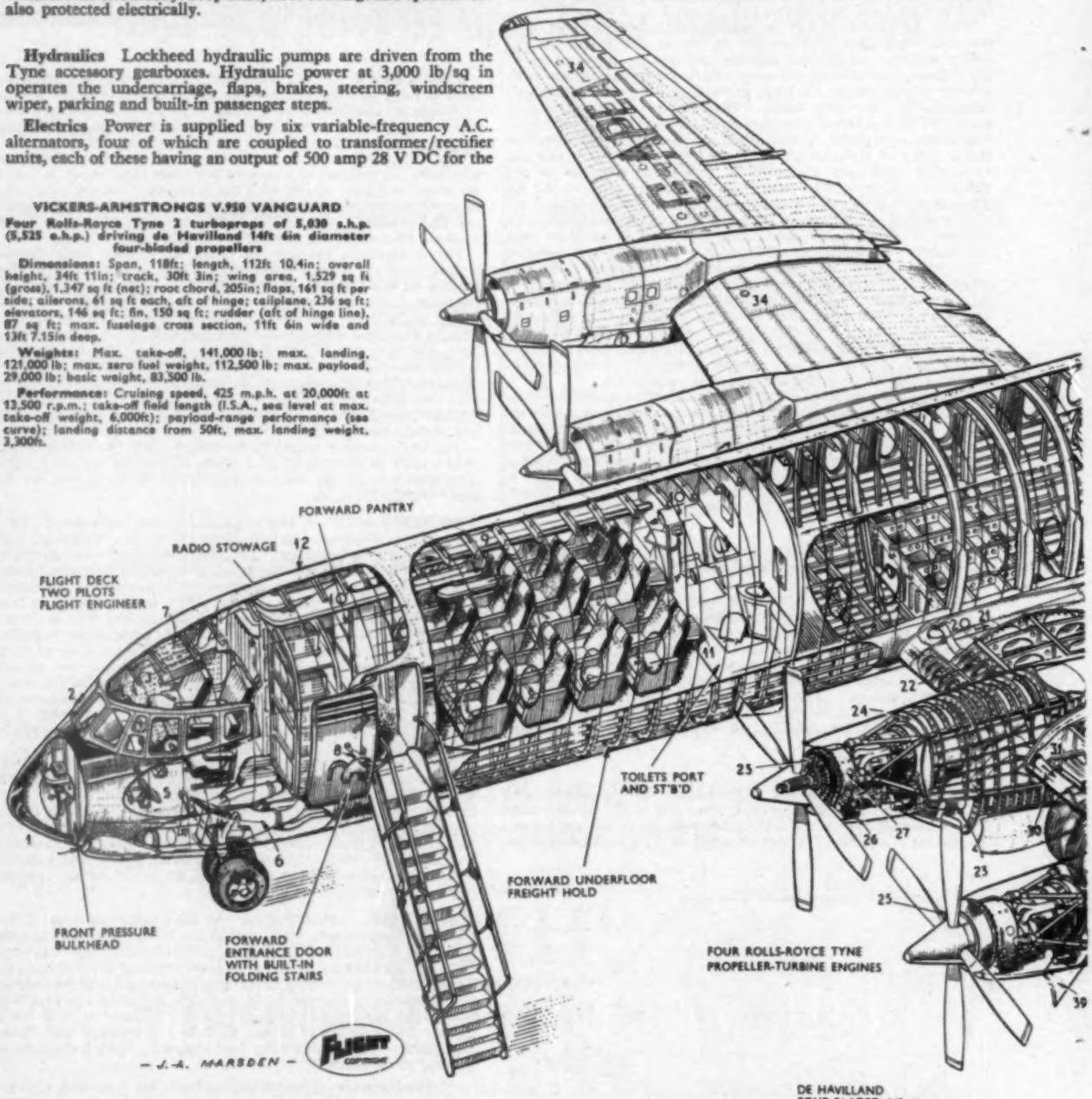
VICKERS-ARMSTRONGS V.950 VANGUARD

Four Rolls-Royce Tyne 2 turboprops of 5,030 s.h.p. (5,525 e.h.p.) driving de Havilland 14ft 6in diameter four-bladed propellers

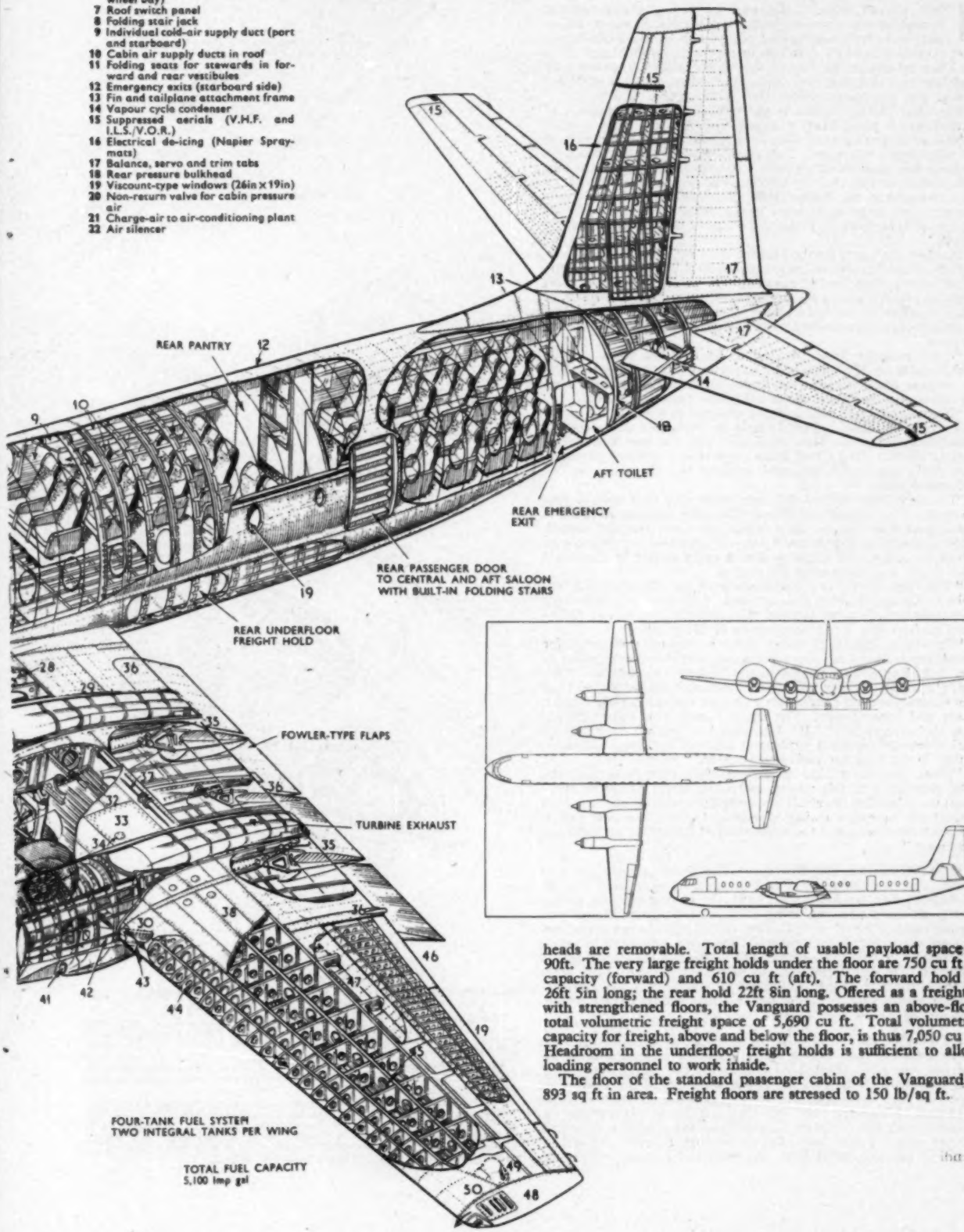
Dimensions: Span, 118ft; length, 112ft 10.4in; overall height, 34ft 11in; track, 30ft 3in; wing area, 1,529 sq ft (gross), 1,347 sq ft (net); root chord, 205in; flaps, 161 sq ft per side; ailerons, 61 sq ft each, aft of hinge; tailplane, 236 sq ft; elevators, 146 sq ft; fin, 150 sq ft; rudder (aft of hinge line), 87 sq ft; max. fuselage cross section, 11ft 6in wide and 13ft 7.15in deep.

Weights: Max. take-off, 141,000 lb; max. landing, 121,000 lb; max. zero fuel weight, 112,500 lb; max. payload, 29,000 lb; basic weight, 83,500 lb.

Performance: Cruising speed, 425 m.p.h. at 20,000ft at 13,500 r.p.m.; take-off field length (I.S.A., sea level at max. take-off weight, 6,000ft); payload-range performance (see curve); landing distance from 50ft, max. landing weight, 3,300ft.



1 Fibreglass radome over cloud-collision-warning radar
2 Electrically heated and demisted windscreen panels
3 Air supply duct to flight deck
4 Adjustable control column
5 Engine, airscrew, flap and trimming control pedestal
6 Air conditioning heat exchangers. Cold-air unit and temperature control system (each side of nose-wheel bay)
7 Roof switch panel
8 Folding stair jack
9 Individual cold-air supply duct (port and starboard)
10 Cabin air supply ducts in roof
11 Folding seats for stewards in forward and rear vestibules
12 Emergency exits (starboard side)
13 Fin and tailplane attachment frame
14 Vapour cycle condenser
15 Suppressed aerials (V.H.F. and I.L.S./V.O.R.)
16 Electrical de-icing (Napier Spraymats)
17 Balance, servo and trim tabs
18 Rear pressure bulkhead
19 Viscount-type windows (26in x 19in)
20 Non-return valve for cabin pressure air
21 Charge-air to air-conditioning plant
22 Air silencer
23 Air filter, blower and silencer
24 Firewall
25 Main engine air intakes
26 Oil cooler
27 Integral engine oil tank
28 Access holes to integral tanks
29 Flattened tailpipe
30 Wing de-icing crossover pipe
31 Main undercarriage machined rib
32 Undercarriage retraction jack
33 Bolted access panel
34 Gravity fillers
35 Double-track flap guide ribs
36 Single-track flap guide ribs
37 Flap torque tube
38 Integrally stiffened wing torque box
39 Petal-type cowlings
40 Accessory gearbox
41 Air intake to de-icing heat exchanger
42 Heat exchanger (outboard nacelles)
43 Ventral exhaust gas outlet
44 De-icing hot-air duct
45 Intercommunicating holes in centre web
46 Spring tab
47 Aileron leading-edge beak
48 Detachable wing-tip
49 Landing lamp
50 De-icing hot-air outlet


REAR PANTRY
AFT TOILET
REAR EMERGENCY EXIT
REAR PASSENGER DOOR TO CENTRAL AND AFT SALOON WITH BUILT-IN FOLDING STAIRS
REAR UNDERFLOOR FREIGHT HOLD
FOWLER-TYPE FLAPS
TURBINE EXHAUST
FOUR-TANK FUEL SYSTEM TWO INTEGRAL TANKS PER WING
TOTAL FUEL CAPACITY 5,100 Imp gal

heads are removable. Total length of usable payload space is 90ft. The very large freight holds under the floor are 750 cu ft in capacity (forward) and 610 cu ft (aft). The forward hold is 26ft 5in long; the rear hold 22ft 8in long. Offered as a freighter with strengthened floors, the Vanguard possesses an above-floor total volumetric freight space of 5,690 cu ft. Total volumetric capacity for freight, above and below the floor, is thus 7,050 cu ft. Headroom in the underfloor freight holds is sufficient to allow loading personnel to work inside.

The floor of the standard passenger cabin of the Vanguard is 893 sq ft in area. Freight floors are stressed to 150 lb/sq ft.

Dart Herald

Handley Page, Ltd., Cricklewood, London

THE aircraft which originated as a four-piston-engined branchliner has now evolved—largely through the air transport industry's widespread acceptance of the Rolls-Royce Dart propeller turbine—into a twin-turboprop branchliner. It is the Dart version of the Herald to which Handley Page are now applying their technical and commercial effort, and it is with this variant that the present description is concerned.

The Dart Herald market is potentially a very large one, and furthermore it is not likely to be influenced by the rapid pace of technological development which at present afflicts the finances of the trunk-route operators. This means that the Herald could be a marketable product for perhaps a decade hence, which puts into perspective the fact that the aircraft is off to a later start than its chief competitor, the Fokker/Fairchild Friendship. Some minor changes have been made since our previous description of this aircraft (*Flight*, May 2, 1958) and a dorsal fin has recently been added.

Handley Page sum up the case for the Dart Herald as follows: "While effort has always been expended on the design and construction of aircraft for the world's better-known routes, there has been no airliner which has brought the same high standards of flight comfort to the branchlines where low purchase cost and economic operation are even more important than on the 'prestige' services.

"Until recently those wishing to fly or send goods on the multitude of lesser—but equally important—airways have had to be content with obsolete mainliners designed for different conditions or with small aircraft offering little passenger appeal.

"Increasing importance is being attached to flying as an everyday means of transport, particularly in territories where surface travel is formidable. This, combined with the specialization of current aircraft design, had made imperative a modern air transport built specifically for local services and operation in undeveloped areas.

"Handley Page realized that only those who used civil aircraft on routes of this type knew with certainty the qualities which such a transport must possess. Representatives of the company investigated operators' requirements by on-the-spot study of their needs. Their enquiries took them to almost every airline in the world with short- and medium-length routes.

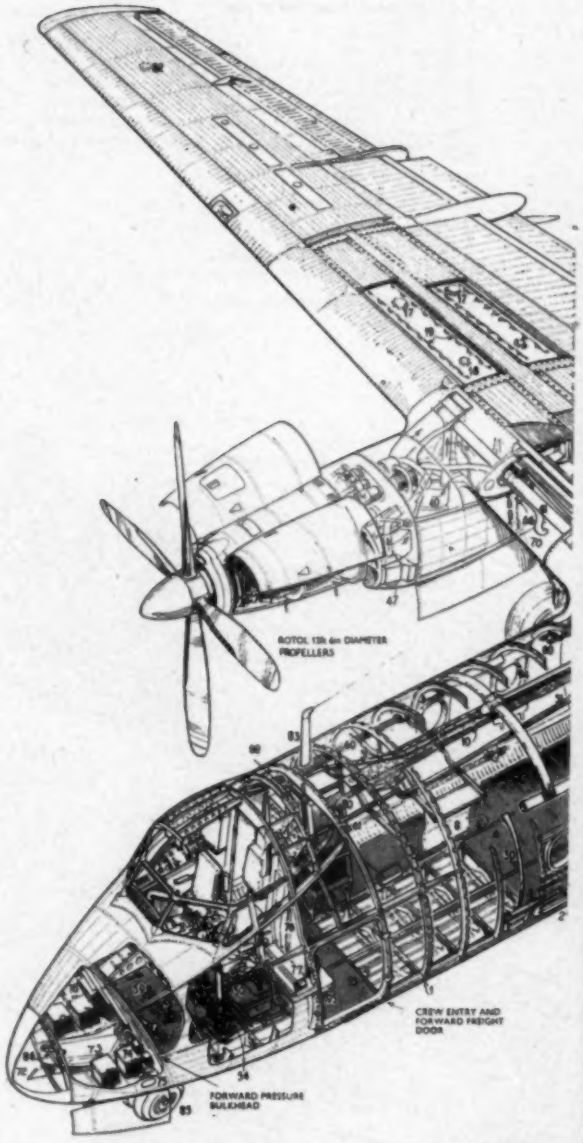
"The Dart Herald is a development of the aircraft which was built to the specification thus evolved. A pressurized, high-wing monoplane of all-metal, stressed-skin construction, its two turboprop engines give it a cruising speed of 275 m.p.h.

"Branchline operators today show a marked preference for turboprop transports. The success and world-wide operation of the Rolls-Royce Dart engine in the Vickers Viscount has made that engine pre-eminent in its field. Since its introduction the Dart has been developed continuously to give increased power and a lower fuel consumption. The engines used on the Dart Herald give the equivalent of 2,100 h.p. each for take-off; their specific fuel consumption, when cruising at 15,000ft in I.S.A. conditions, is 0.66 lb per hour per shaft horse-power.

"More than four million engine hours have been flown by Darts. The popularity of this engine among its many operators arises from its reliability, the small number of propeller featherings that have been necessary owing to engine trouble, the long period between overhauls, and the small amount of routine maintenance necessary."

COMMERCIAL HISTORY The Herald project was first announced in October 1954 and the first Alvis-engined Herald, G-AODE, flew on August 25, 1955, the second machine taking to the air just over a year later. Early interest in the Herald was strong (options on 35 aircraft were placed by four operators) but airlines subsequently became more and more influenced by world acceptance of the Rolls-Royce Dart. This led Handley Page, in May 1957, to concentrate on the twin-Dart version. First flight of the converted Herald took place in March 1958 and certification is planned by the year end. No firm orders have yet been announced for the Dart Herald.

STRUCTURE The Herald airframe has been extensively re-stressed for Dart power. As a result of structural tests, the fuselage has been granted an infinite fatigue life by the A.R.B. and tests are now in hand for similar clearance of the wing. The structure has been designed according to the fail-safe multiple load-path philosophy. The new Dart installation has involved the complete redesign of the existing wing, which carries an additional 30 per cent bending load (due to the higher speed and lack of bending moment relief from the outboard engines). This has



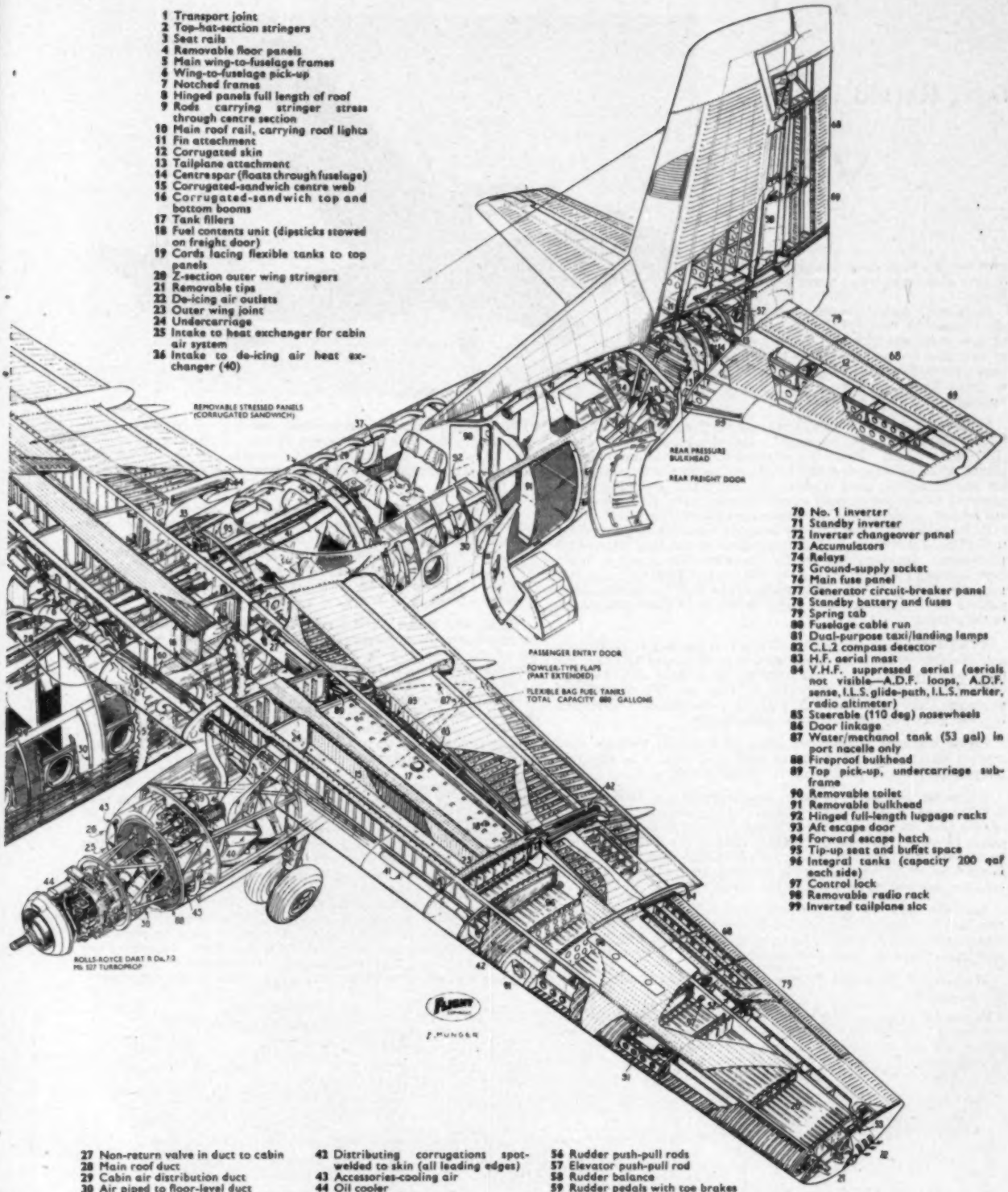
HANDLEY PAGE DART HERALD

Two Rolls-Royce Dart RDa.7/2 Mark 527 turboprops of 2,100 e.h.p., each driving Rotol four-bladed, 13½ft propellers

Dimensions: Span, 94ft 9½in; length, 71ft 11in; height, 22ft 4in; wing area, 806 sq ft; flaps, 91 sq ft each side; ailerons, 29.7 sq ft each; tailplane, 252 sq ft; elevator, 71.13 sq ft; fin and rudder (total), 193 sq ft; track, 22ft; wheelbase, 25ft 10in.

Weights: Basic operating weight, 36-seater, 22,269 lb; max. payload, 10,160 lb; zero fuel weight, 32,968 lb; max. take-off weight (also max. landing weight), 37,000 lb.

Performance: Take-off, balanced field length, sea level standard conditions, 3,700ft; tropical conditions (I.S.A. +15 deg C conditions), 3,950ft; sea level rate of climb, 1,580ft/min; rate of climb at 10,000ft, 1,030ft/min; cruising speed at 35,000 lb, standard conditions, at 17,400ft, 241 kt; stalling speed, max. weight, sea level standard conditions, 69 kt; landing distance from 50ft, 2,260ft; corresponding distance in I.S.A. +15 deg C conditions, 2,350ft.


REMOVABLE STRESSED PANELS (CORRUGATED SANDWICH)
REAR PRESSURE BULKHEAD
REAR FREIGHT DOOR
PASSENGER ENTRY DOOR
FOWLER-TYPE FLAPS (PART EXTENDED)
FLEXIBLE BAG FUEL TANKS TOTAL CAPACITY 680 GALLONS
ROLLS-ROYCE DART R Da.7-2 Mk. 527 TURBOPROP
FLIGHT
P. MUNGER

1 Transport joint
2 Top-hat-section stringers
3 Seat rails
4 Removable floor panels
5 Main wing-to-fuselage frames
6 Wing-to-fuselage pick-up
7 Notched frames
8 Hinged panels full length of roof
9 Rods carrying stringer stress through centre section
10 Main roof rail, carrying roof lights
11 Fin attachment
12 Corrugated skin
13 Tailplane attachment
14 Centre spar (floats through fuselage)
15 Corrugated-sandwich centre web
16 Corrugated-sandwich top and bottom booms
17 Tank fillers
18 Fuel contents unit (dipsticks stowed on freight door)
19 Cords lacing flexible tanks to top panels
20 Z-section outer wing stringers
21 Removable tips
22 De-icing air outlets
23 Outer wing joint
24 Undercarriage
25 Intake to heat exchanger for cabin air system
26 Intake to de-icing air heat exchanger (40)

70 No. 1 inverter
71 Standby inverter
72 Inverter changeover panel
73 Accumulators
74 Relays
75 Ground-supply socket
76 Main fuse panel
77 Generator circuit-breaker panel
78 Standby battery and fuses
79 Spring tab
80 Fuselage cable run
81 Dual-purpose taxi/landing lamps
82 C.L.2 compass detector
83 H.F. aerial mast
84 V.H.F. suppressed aerial (aerials not visible—A.D.F. loops, A.D.F. sense, I.L.S. glide-path, I.L.S. marker, radio altimeter)
85 Steerable (110 deg) nosewheels
86 Door linkage
87 Water/methanol tank (53 gal) in port nacelle only
88 Fireproof bulkhead
89 Top pick-up, undercarriage sub-frame
90 Removable toilet
91 Removable bulkhead
92 Hinged full-length luggage racks
93 Aft escape door
94 Forward escape hatch
95 Tip-up seat and buffet space
96 Integral tanks (capacity 200 gal each side)
97 Control lock
98 Removable radio rack
99 Inverted tailplane slot

27 Non-return valve in duct to cabin
28 Main roof duct
29 Cabin air distribution duct
30 Air piped to floor-level duct
31 Air to cockpit and windscreen de-misters
32 Cockpit air louvres
33 Mass flow control
34 Main discharge valve
35 Inwards relief and safety valves
36 Pipe from controller in cockpit
37 Individual punkah louvres
38 Fuel heater
39 Accessory-box drive
40 De-icing heat exchanger on tailpipe
41 Hot air cross-feed and supply to tail surfaces
42 Distributing corrugations spot-welded to skin (all leading edges)
43 Accessories-cooling air
44 Oil cooler
45 Cabin-air silencer
46 Cabin blower
47 Cabin-air heat exchanger
48 6 kW generator
49 7.3 kVA alternator
50 Aileron torque rod from column cross-shaft
51 Aileron push-pull rods
52 Aileron spring-tab torsion bar
53 Aileron mass-balance
54 Rudder and elevator levers
55 Rudder and elevator tension rods (under floor)
56 Rudder push-pull rods
57 Elevator push-pull rod
58 Rudder balance
59 Rudder pedals with toe brakes
60 Pitch and power push-pull rods
61 Trim and control-lock cables
62 Flap lowering chain
63 Flap ram
64 Flap guide rails
65 Flap operating cables
66 Flap and undercarriage emergency-lowering air bottle
67 Starboard console, mainly electrics (port console, mainly electrics, not shown)
68 Trim tab
69 Balance tab

Dart Herald . . .

involved the addition to the centre section of new main upper and lower centre spar flanges.

In general, design has been according to the philosophy that, for the Herald's type of operation, the airframe must continue to maintain its performance when it has been operated hard for many years—when, to quote *Flight* for May 2, "it is patched and dirty and even a little dented."

POWERPLANT The Dart Herald is powered by two Rolls-Royce Dart RDa.7/2 Mark 527 turboprops of 2,100 e.h.p. (1,910 s.h.p.) each. There is a substantial degree of interchangeability with the Viscount 810 installation, a fact which accounts for the straightforward manner in which the Dart Herald is expected to proceed through its certification trials. In one important respect, however, the powerplant is different from that of the 810. Rotol propellers of 12ft 6in diameter—the largest yet applied to the Dart—will be used. This compares with the 10ft (trapezoidal plan-form) propeller used on the Viscount. Tip speed is, however, comparable, with that of the Viscount. The larger diameter propellers permit full use to be made of the Dart's power for good take-off field performance, a factor which is of great importance to the Herald.

SYSTEMS **Fuel System** Total fuel capacity is 1,080 Imp. gal. Flexible tanks in the centre section each contain 180 Imp. gal (two tanks forward) and 160 Imp. gal (two tanks aft). Integral tanks in each outer wing each carry 200 Imp. gal. Water-methanol to restore Dart power in I.S.A.+30 deg C conditions is contained in a single 53 Imp. gal tank in the port nacelle.

Flying Controls These are operated manually through steel tension rods, cable and chains or push-pull rods. The flaps are hydraulically operated through a system of cables.

Cabin Air System The cabin is pressurized to a differential of 3.35 lb/sq in. Ram air enters intakes in the centre section outboard of each Dart nacelle and passes through two engine-driven Godfrey cabin blowers. The air is ducted thence to a silencer and then to a heat exchanger for cooling. Final distribution to the cabin is via roof ducts. A Normalair pressure controller is fitted. A cold-air unit can be installed in the dorsal fairing.

Ice Protection Wings, tail unit and fin are protected from ice formation by hot air supplied by jet-pipe heated air. The windscreen is protected by a liquid system; the propellers and air intakes and pitot-heads are protected electrically.

Hydraulics Hydraulic power, which serves undercarriage extension and retraction, nosewheel steering, wheel brakes and flaps, is supplied by a pump driven by each engine accessory gearbox. A separate hydraulic system, supplied by an electrically driven pump, is used for emergency operation of the undercarriage and flaps.

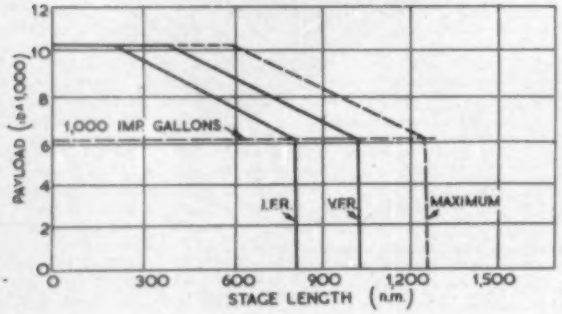
Electrics Two 28V, 6kW DC generators, one driven by each engine, supply electrical power. AC, supplied for propeller and intake de-icing, is provided by two 7.3kVA, 208V, alternators (Viscount-type). The split busbar arrangement of the earlier Herald is retained, and safeguards against electrical failure are claimed by Handley Page to be unequalled by any other twin-engined aircraft.

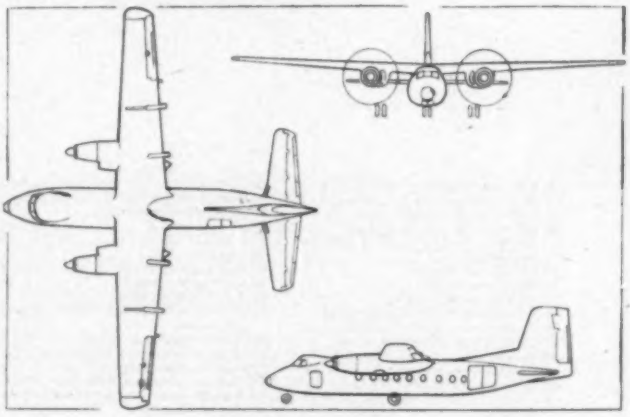
Radio and Radar Radio equipment is variable according to requirements. A separate radio operator's position can be installed aft of the flight deck (at the expense of some payload space) in addition to the normal crew complement of two pilots.

The Herald is offered as an airborne radio and radar calibrator. The requirement for ground-aids-calibration aircraft is likely to increase rather than diminish with the increase of air transport and air traffic control facilities, and the Herald with its large capacity and long endurance (up to 11 hr with an extra 400 gal tank) appears to be a suitable contender in this rôle.

Payload Accommodation Standard seating arrangement is 36 in nine rows of two double chairs at 38in pitch. Alternative versions can provide for up to 47 passengers. A total volume of 1,682 cu ft, with floors stressed to 150 lb/sq in accordingly, is available for freight. There are two entrance doors; one on the port side towards the rear is an outward-opening double door 5ft 4in high by 5ft 5in wide. Its forward section is used for passenger entry, and both sections are opened for freight. Also on the port side, at the forward end of the cabin, is a second door, 3ft 10in×3ft. This door is used for crew entry and can also be used for passengers and freight. A movable partition separates passengers from freight in mixed traffic operations. Handley Page are also devising a rear loading door split horizontally and hinged top and bottom. The lower half contains built-in passenger steps.

The payload range curve is drawn for the 36-seat Dart Herald and assumes I.S.A., still air. Allowances are made for take off, climb, cruise and descent for max. range and for chock to chock fuel and 45 min stand off at 1,000ft for V.F.R., and for 200 mile diversion or return and 45 min at 5,000ft for I.F.R.

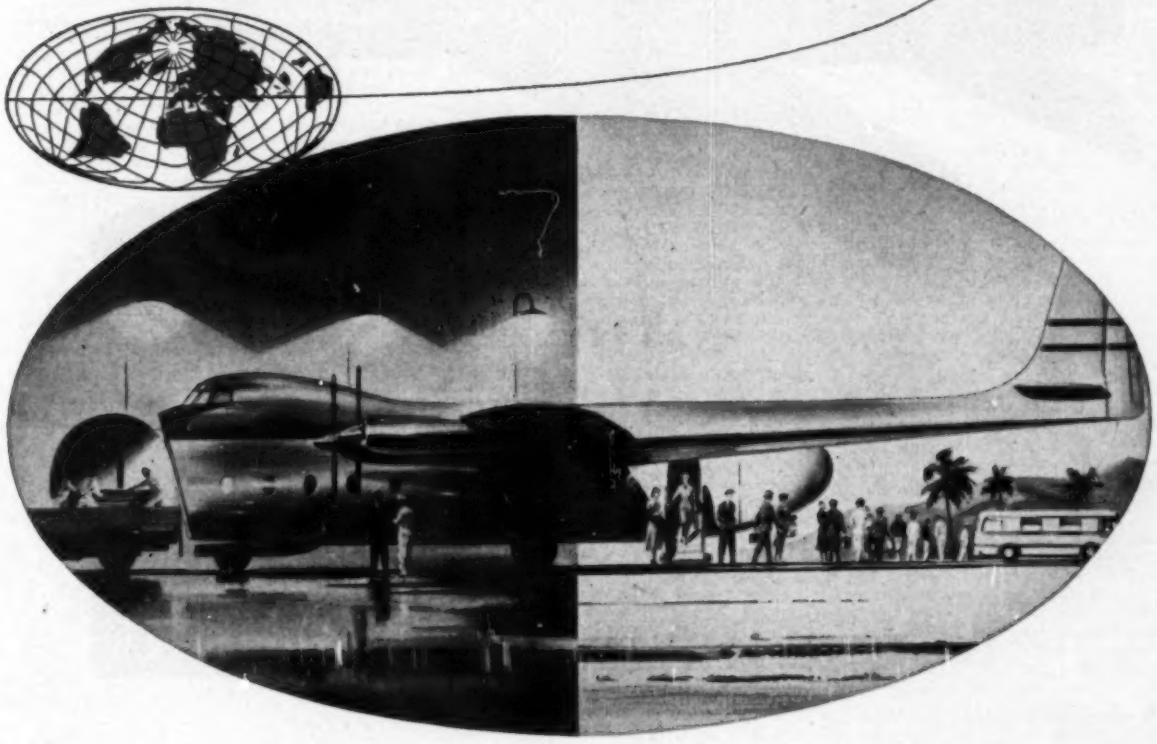




Airline Adaptability

This, the world's first pressurised turbo-prop freightercoach, is the ideal aircraft for airfreight and aircoach operators, for it is the result of a world-wide study of their problems. The AW 650 in range and payload is designed to suit 90% of airline route systems in the 1960's. High utilisation is ensured by wide payload/range variation embracing internal and international route structures, quick turn-round facilities, quick conversion of rôle and a 300 m.p.h. cruising speed. The standard version has four proved Rolls-Royce Dart engines and has a range of up to 3,000 miles without reserves. There is also a twin-engined version — the AW 651 — powered by Rolls-Royce Tyne engines.

THE AW650 Turbo-Prop Freightercoach

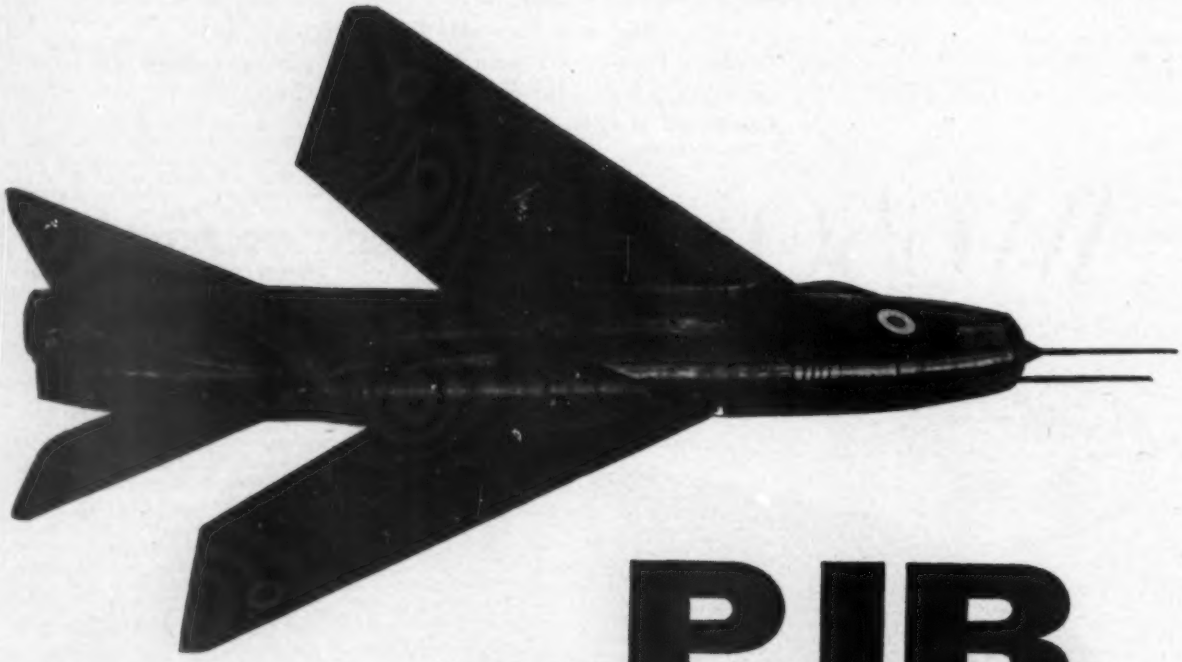


SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD. / Baginton, Coventry, England.

MEMBER OF HAWKER SIDDELEY / ONE OF THE WORLD'S INDUSTRIAL LEADERS

FOR ITS FUTURE DEVELOPMENT POSSIBILITIES...

The ENGLISH ELECTRIC P.1B is one of the most advanced fighters in the world. Even so the basic design has further great potential development—not only in performance, but also in adaptation to other operational roles. This built-in stretch offers economies of production and operation as well as ensuring that, tactically speaking, it can be adapted to meet any situation which may arise.



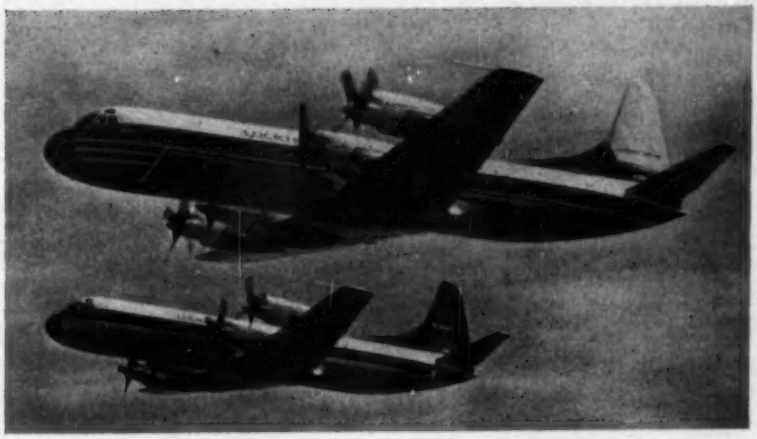
...THE P.1B IS INCOMPARABLE

'ENGLISH ELECTRIC' aircraft

The ENGLISH ELECTRIC Company Limited · Marconi House · Strand · London WC2

Electra

Lockheed Aircraft Corporation (California Division), Burbank, California

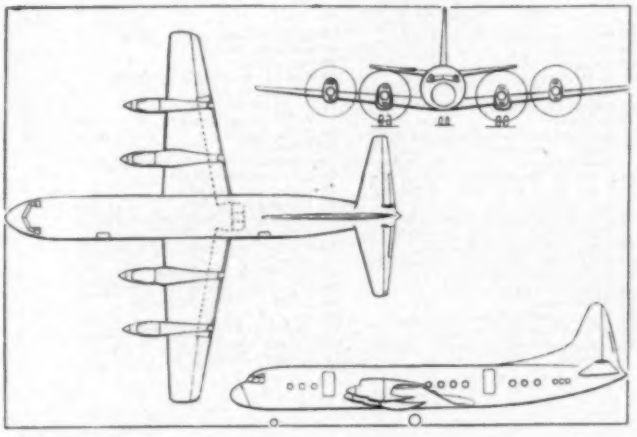


IN the early weeks of 1957, only the vestiges of an Electra production line were visible at Burbank. Lockheed were then gathering their production effort for an outstandingly rapid turnout of airframes to succeed the first aircraft to leave the line. Now, seven months after the Electra's first flight on December 6, five aircraft are airborne and assembly of the thirty-fifth is already under way. Following successful certification (scheduled to be obtained by August 22), Lockheed expect to deliver 12 aircraft before the end of the year, and by the autumn ground and airborne hours run on the Allison 501 engine should have reached 350,000.

The Electra—first U.S. commercial turboprop airliner—is offered to a world conditioned by Viscount success as the economical partner of the big jets on medium and short-haul routes down to 200 miles. As a result of extensive (and expensive) tooling, the break-even figure has been set high; but substantial orders from airlines may see this break-even figure exceeded before the first aircraft are in service. Six requirements given by C. R. Smith of American Airlines for his company's selection of a medium range aircraft are worth quoting for the light they shed on one airline's choice of the Electra: (1) high speed "block to block" to remain competitive; (2) ease and economy of handling in lower altitudes because of the need to make many landings and take-offs; (3) ability to operate on moderate-length runways; (4) ability to make intermediate stops without refuelling each time; (5) a size "not too large nor too small" for efficiency on low-traffic routes, yet with enough stretch to handle anticipated growth "without undue increase in schedule frequency"; (6) "provable economy."

COMMERCIAL HISTORY When the Electra was first announced it was naturally coupled with **American Airlines** who had drawn up a formal specification and issued this to the aircraft industry. In January 1955 four manufacturers submitted designs and in the following June an order was placed with Lockheed for 35 Electras to be delivered from August 1958 to mid-1959. The first flight was ambitiously planned for October 1957 and actually took place two months after that date. American's first two aircraft are likely to be delivered in December. **Eastern** placed an order for 40 Electras subsequently to American's order (in September 1955) but secured earlier delivery dates and should receive ten of the 12 this year.

The following orders have brought Electra sales to over 161, all these (except for the earlier American and Eastern aircraft) being due for delivery in 1959-60: **Braniff,** 9 in December 1955; **National,** 23 in January 1956; **K.L.M.,** 12 in March 1956; **Western,** 9 in April 1956; **Garuda,** 3 in February 1957; **Cathay Pacific,** 2 in September 1957; **Pacific Southwest,** 3 in September 1957; **Ansett/A.N.A.,** 2 (previously 4) in September 1957; **Aeronaves de Mexico,** 3 in November 1957; **Qantas,** 4 in May 1957; **T.E.A.L.,** 3 in May 1958; **T.A.A.,** 2 in May 1958; and **Northwest,** 10 in May 1958. A possible order for two Electras was reported in February 1957 for Loftleidir but this has subsequently been cancelled. An aircraft has also been purchased by (and delivered to) General Motors' Allison Division for engine development and testing. Lockheed have a $2m research and development contract for Electras for the U.S. Navy. A subsequent order for 200 aircraft seems likely.



STRUCTURE Fail-safe philosophy has been extensively applied to the primary structure. No part of the pressurized section, for example, has a stress exceeding 12,000 lb/sq in.

The fuselage is of circular section and truly cylindrical for the greater length of the passenger cabin. Lipped-channel frames are generally spaced at 19in pitch and are notched to accommodate rolled section stringers. Basis of the wing structure is a spanwise torsion box formed by front and rear spars, closely spaced girder ribs, and upper and lower integrally stiffened panels. A contribution to the fail-safe design is obtained by dividing the vertical plate webs into upper and lower sections and providing spanwise joints in the stiffened skin.

Undercarriage The gear is designed and manufactured by Menasco. The main legs are each single forgings braced by pin-jointed upper and lateral arms and carry forged wheels, three-disc, single-unit hydraulic brakes and 13.50-16 tyres inflated to 138 lb/sq in. Limiting speed for undercarriage extension is 190 kt E.A.S. The nose undercarriage is similar in geometry and carries forged twin wheels and 7.50-14 tyres. The unit can be steered through 67 deg for a turning radius about either main leg of 65ft.

POWERPLANT The Electra's engines are Allison 501-D13 turboprops of 3,750 c.s.h.p. The power section consists of a 14-stage compressor, a can-annular combustion chamber and a four-stage turbine. Power section and reduction gear are supplied as separate packages, which are connected by a tubular coupling shaft of substantial length and diameter. Accessory drives, torquemeter and safety devices are positioned on the casing of the gearbox, which reduces the 13,820 r.p.m. constant rotational speed of the engine to 1,020 at the propeller. The last-named is a 13ft 6in diameter Aeroproducts A6441FN-606 unit (although Hamilton Standard 54H60 propellers will be fitted for K.L.M.) with selective pitch and negative torque control, synchronization and blade-phase control.

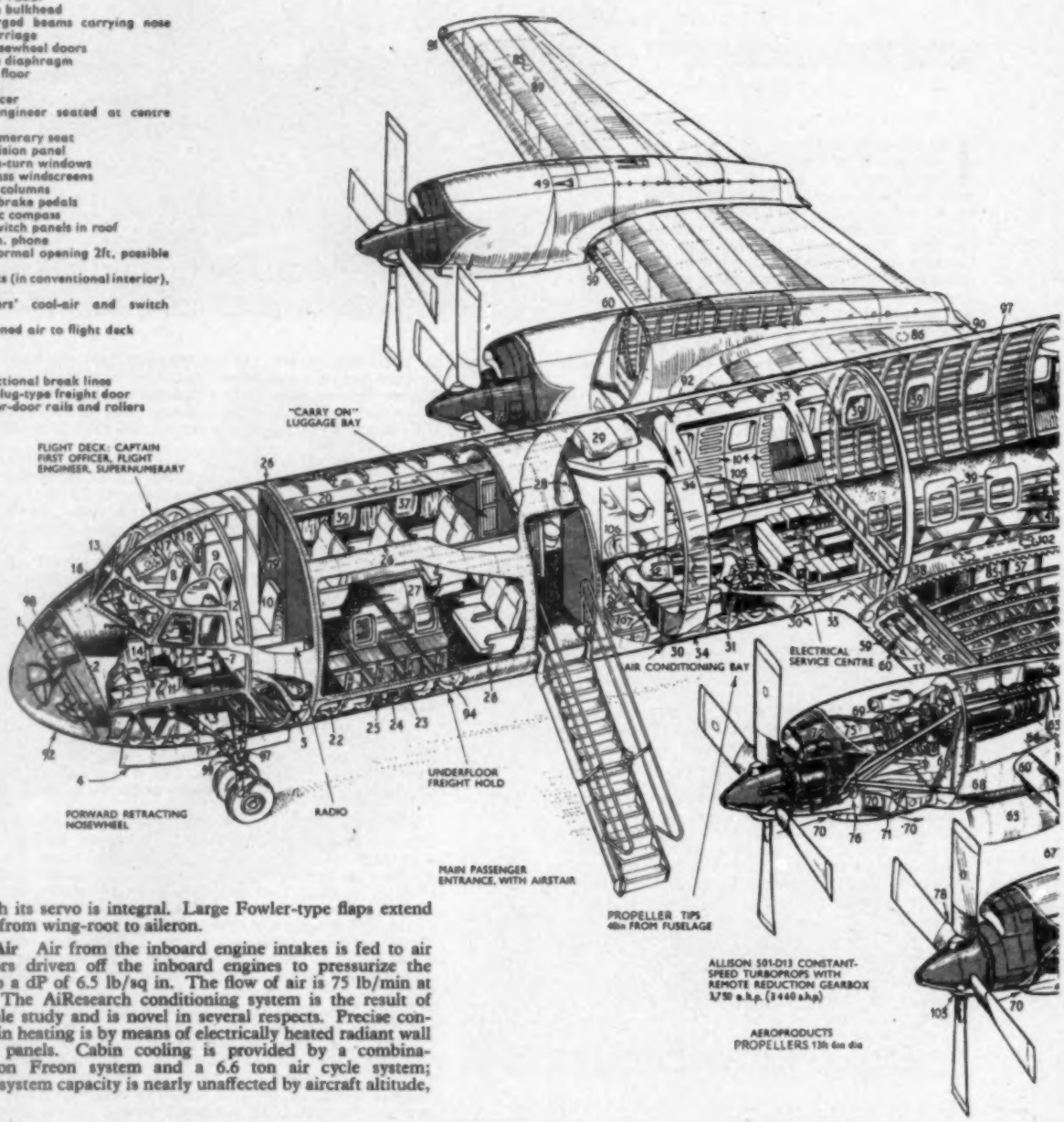
Installed as self-contained packages, the powerplants include the nacelle and tailpipe, which lies within a stainless steel box over the wing spars. Oil tanks are mounted directly over the engines and an oil cooler is mounted underneath and cooled by ram air. Starting is by pneumatic means, one air turbine starter unit being mounted on each engine. All four engines can be started in about 90 seconds.

SYSTEMS **Fuel System** A four-tank system is provided by division of the wing box. Auto-trimming, crossfeed and dumping facilities (for all except 150 gal from each tank) are available and the tanks may be refuelled either by gravity or from a central refuelling-defuelling socket in the rear of No. 3 engine nacelle. This feeds a spanwise manifold at 300 gal/min. and at a pressure of 35 lb/sq in. The total tankage is 4,464 Imp. gal; 908 Imp. gal are contained in each inner tank and 1,324 Imp. gal in the outers —only about five gal per tank being unusuable fuel.

Flying Controls All surfaces are actuated through hydraulic booster units which provide proportional feel at columns and pedals. Manual reversion is possible and is accompanied by a change of mechanical advantage between the column and the surface and a reduction in the surface angle limits of travel. The Bendix PB20E autopilot acts directly upon the hydraulic boosters,

Electra . . .

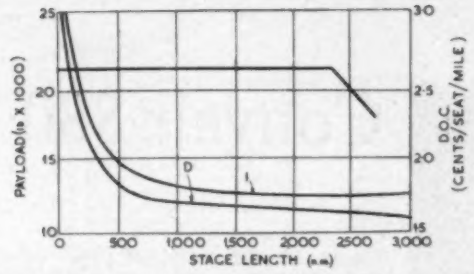
1 Weather radar
2 Pressure bulkhead
3 Two forged beams carrying nose undercarriage
4 Twin nosewheel doors
5 Pressure diaphragm
6 Cockpit floor
7 Captain
8 First officer
9 Flight engineer seated at centre console
10 Supernumerary seat
11 Direct-vision panel
12 Vision-in-turn windows
13 Nesa glass windscreens
14 Control columns
15 Rudder/brake pedals
16 Magnetic compass
17 Large switch panels in roof
18 Intercom. phone
19 Door, normal opening 2ft, possible 4ft
20 Hat racks (in conventional interior), see 48
21 Passengers' cool-air and switch panels
22 Conditioned air to flight deck
23 Fan
24 Filter
25 Heater
26 Constructional break lines
27 Sliding plug-type freight door
28 Passenger-door rails and rollers


"CARRY ON" LUGGAGE BAY
FLIGHT DECK: CAPTAIN FIRST OFFICER, FLIGHT ENGINEER, SUPERNUMERARY
AIR CONDITIONING BAY
ELECTRICAL SERVICE CENTRE
UNDERFLOOR FREIGHT HOLD
FORWARD RETRACTING NOSEWHEEL
RADIO
MAIN PASSENGER ENTRANCE, WITH AIRSTAIR
PROPELLER TIPS 48in FROM FUSELAGE
ALLISON 501-D13 CONSTANT-SPEED TURBOPROPS WITH REMOTE REDUCTION GEARBOX 3,750 s.h.p. (3,460 a.h.p.)
AEROPRODUCTS PROPELLERS 13ft 6in dia

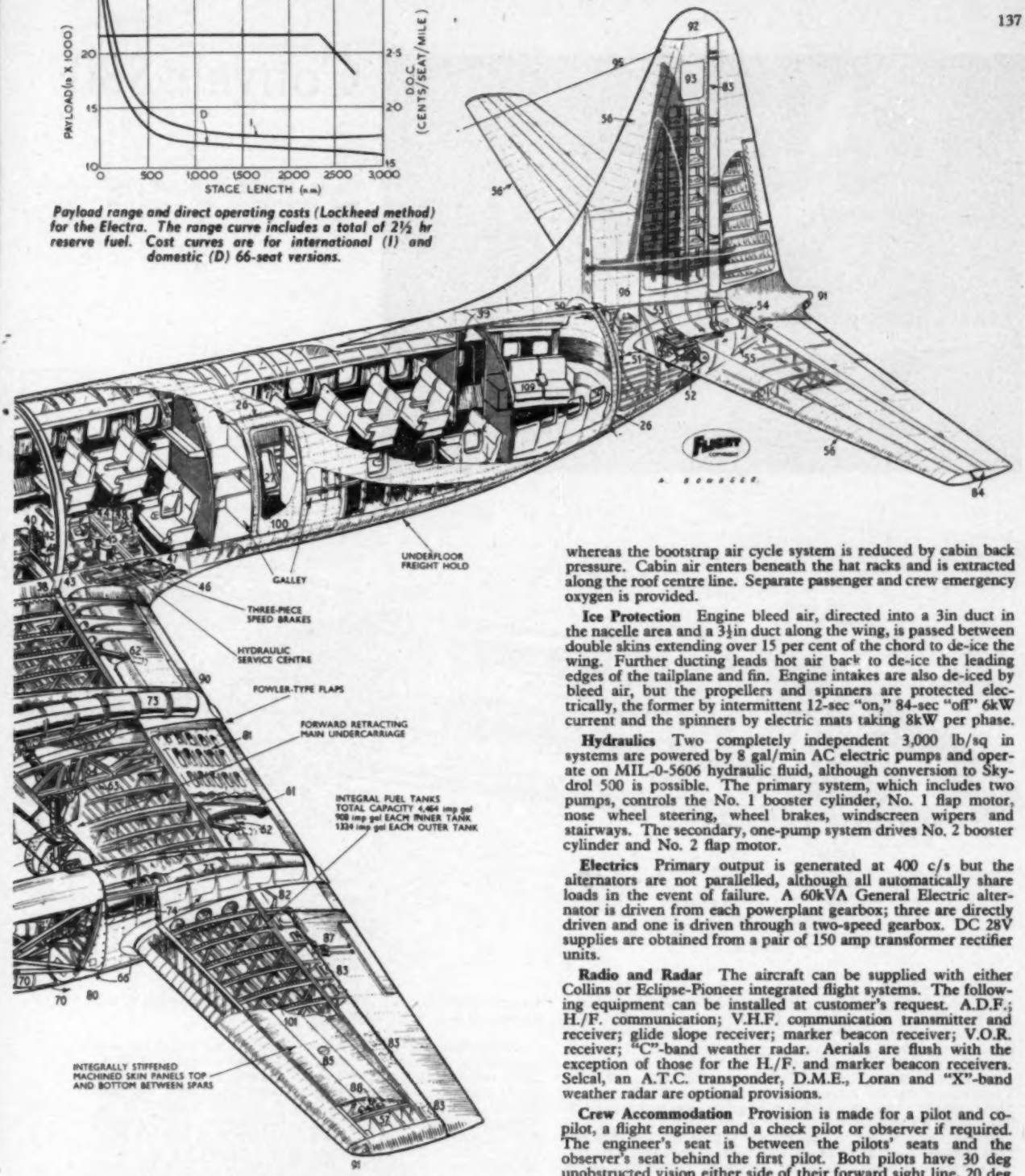
with which its servo is integral. Large Fowler-type flaps extend unbroken from wing-root to aileron.

Cabin Air Air from the inboard engine intakes is fed to air compressors driven off the inboard engines to pressurize the fuselage to a dP of 6.5 lb/sq in. The flow of air is 75 lb/min at 30,000ft. The AiResearch conditioning system is the result of considerable study and is novel in several respects. Precise control of cabin heating is by means of electrically heated radiant wall and floor panels. Cabin cooling is provided by a combination ten-ton Freon system and a 6.6 ton air cycle system; the Freon system capacity is nearly unaffected by aircraft altitude,

29 Fresh-water tank
30 Airflow through heat exchanger
31 Twin air-cycle unit
32 Condenser/fan unit
33 Cabin air from compressors on inboard gearboxes
34 Central access hatch
35 Roof ducting, air-conditioning
36 Conditioned-air riser to 35
37 Windows 16in x 18in
38 Wing/fuselage joint, front and rear spars
39 Emergency exits
40 Aileron hydraulic booster unit on rear spar
41 Pilot-input cables to 40
42 Brake accumulator
43 Emergency brake air bottle
44 Hydraulic pumps (electrically driven)
45 Hydraulic reservoirs, 3,000 lb/sq in system
46 Speed-brake panels
47 Speed-brake screw-jack
48 Speed-brake motor on starboard fillet
49 Cooling-air intakes to jet-pipe shroud
50 Pressure outflow valves
51 Inflow valve
52 Rudder booster unit (port)
53 Elevator booster unit (starboard)
54 Universal joint in elevator tube
55 Access hatch
56 Tail hot air anti-icing
57 Tank end-ribs
58 Engine bleed-air for wing anti-icing
59 Hot-air injectors (40 per foot) and double skin
60 Leading edge hinged for inspection
61 Flap track and roller assemblies (five each side)
62 Flap actuators
63 Forged ribs carrying main undercarriage
64 Undercarriage jack
65 Four doors to each main-wheel box
66 Firewalls
67 Multi-disc brakes
68 Wheel box
69 Oil tank
70 Airflow through oil cooler
71 Oil-cooler flap jack
72 Engine-air intake
73 Jet pipes
74 Stainless-steel heat-resistant trough
75 Engine drive-shaft to reduction gearbox
76 Cabin air compressor
77 N.A.C.A. intake to 76 (inner engines only)
78 Electrically de-iced blade-cuffs and blade-islands. Spinner anti-icing
79 Main engine-mounting point
80 Air turbine starters on each engine
81 Bonded double skin
82 Aileron linkage
83 Mass balances
84 Horn/mass balance
85 Gravity fuel filler
86 Pressure-refuelling point (under nacelle)
87 Twin (fail-safe) trim actuator
88 Fuel vent valves
89 Fuel probes
90 Fuel dump valves in this area
91 Navigation lights
92 V.H.F. aerial
93 V.O.R. aerial window
94 D.M.E. aerial
95 H.F. aerial
96 Integral fin and rear fuselage
97 Landing/taxi lights
98 Glide slope aerial
99 Steering cylinders
100 Passenger or galley service door
101 Tank-inspection panels
102 A.D.F. loop and sense aerials under belly
103 Variable low-pitch stop
104 Electrically heated wall panels
105 Cabin air for recirculation
106 Recirculating fan
107 Heater and Freon evaporator
108 Freon compressor
109 Six-seat lounge



Payload range and direct operating costs (Lockheed method) for the Electra. The range curve includes a total of 2½ hr reserve fuel. Cost curves are for international (I) and domestic (D) 66-seat versions.


UNDERFLOOR FREIGHT HOLD
GALLEY
THREE-PIECE SPEED BRAKES
HYDRAULIC SERVICE CENTRE
FOWLER-TYPE FLAPS
FORWARD RETRACTING MAIN UNDERCARRIAGE
INTEGRAL FUEL TANKS
TOTAL CAPACITY 4,464 imp gal
908 imp gal EACH INNER TANK
1334 imp gal EACH OUTER TANK
INTEGRALLY STIFFENED MACHINED SKIN PANELS TOP AND BOTTOM BETWEEN SPARS

LOCKHEED L.188 ELECTRA

Four 3,758 e.s.h.p. Allison 501-D13 turboprops driving 13ft 6in diameter Aeroproducts or Hamilton Standard propellers

Dimensions: Span, 99ft; gross wing area, 1,300 sq ft; span of horizontal tail, 42ft 10in; overall length, 104ft 6.5in; fuselage outside diameter, 136in; inside diameter, 128in; overall aircraft height, 32ft 9.2in; track, 31ft 2in; wheelbase, 37ft.

Weights: Basic operating weight, 59,338 lb; max. weight, 113,000 lb; take-off weight for 500-mile flight, 95,000 lb; "normal landing weight with 85 passengers and reserve fuel," 88,733 lb; design landing weight, 95,650 lb; max. zero-fuel weight, 80,910 lb in current Electras, increased to 86,000 lb in future production; payload, 21,195 lb (space limited) in current aircraft, increased to 26,500 lb (weight limited) in later machines.

Performance: Typical cruising speed is quoted as 403 m.p.h. (weight not stated); take-off field length (standard day, 113,000 lb), 5,470ft; (hot day, +40 deg F), 7,550ft; landing field length (standard day, 95,650 lb), 5,400ft; climb at 113,000 lb, 15,000ft in 13 min or 20,000ft in 23 min.

whereas the bootstrap air cycle system is reduced by cabin back pressure. Cabin air enters beneath the hat racks and is extracted along the roof centre line. Separate passenger and crew emergency oxygen is provided.

Ice Protection Engine bleed air, directed into a 3in duct in the nacelle area and a 3½in duct along the wing, is passed between double skins extending over 15 per cent of the chord to de-ice the wing. Further ducting leads hot air back to de-ice the leading edges of the tailplane and fin. Engine intakes are also de-iced by bleed air, but the propellers and spinners are protected electrically, the former by intermittent 12-sec "on," 84-sec "off" 6kW current and the spinners by electric mats taking 8kW per phase.

Hydraulics Two completely independent 3,000 lb/sq in systems are powered by 8 gal/min AC electric pumps and operate on MIL-0-5606 hydraulic fluid, although conversion to Skydrol 500 is possible. The primary system, which includes two pumps, controls the No. 1 booster cylinder, No. 1 flap motor, nose wheel steering, wheel brakes, windscreen wipers and stairways. The secondary, one-pump system drives No. 2 booster cylinder and No. 2 flap motor.

Electrics Primary output is generated at 400 c/s but the alternators are not parallelled, although all automatically share loads in the event of failure. A 60kVA General Electric alternator is driven from each powerplant gearbox; three are directly driven and one is driven through a two-speed gearbox. DC 28V supplies are obtained from a pair of 150 amp transformer rectifier units.

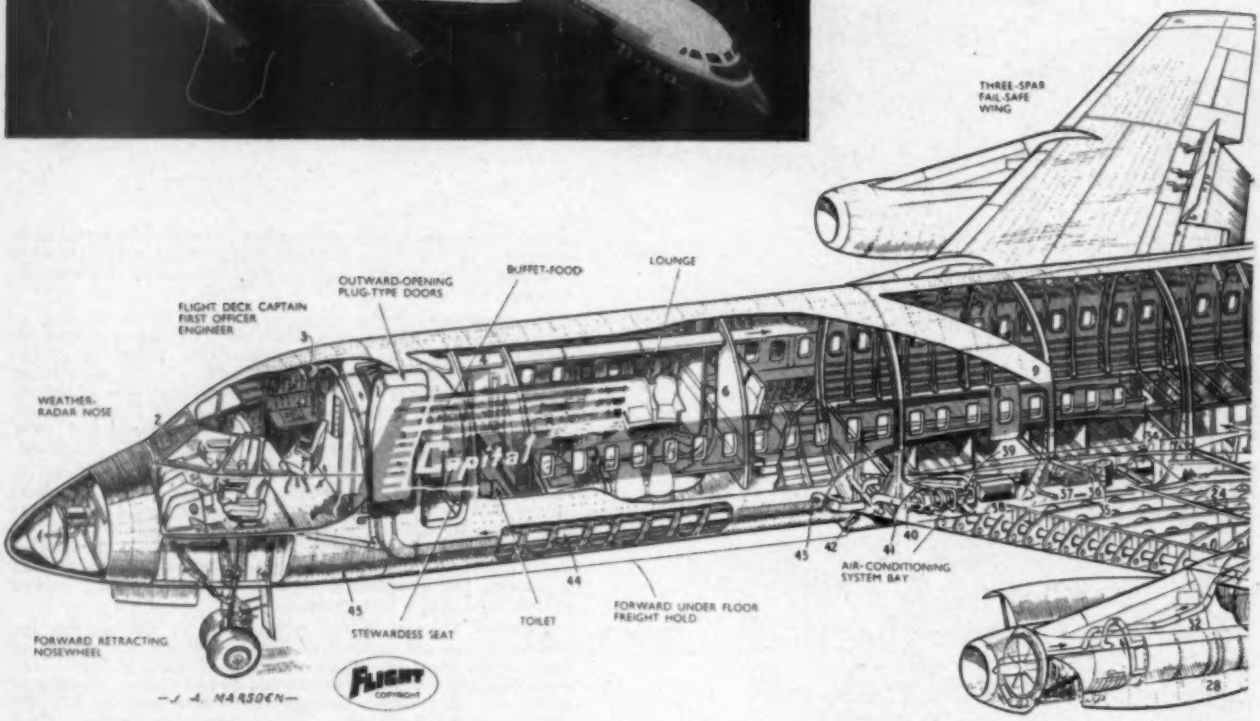
Radio and Radar The aircraft can be supplied with either Collins or Eclipse-Pioneer integrated flight systems. The following equipment can be installed at customer's request. A.D.F.; H./F. communication; V.H.F. communication transmitter and receiver; glide slope receiver; marker beacon receiver; V.O.R. receiver; "C"-band weather radar. Aerials are flush with the exception of those for the H./F. and marker beacon receivers. Selcal, an A.T.C. transponder, D.M.E., Loran and "X"-band weather radar are optional provisions.

Crew Accommodation Provision is made for a pilot and co-pilot, a flight engineer and a check pilot or observer if required. The engineer's seat is between the pilots' seats and the observer's seat behind the first pilot. Both pilots have 30 deg unobstructed vision either side of their forward sight line, 20 deg up and 15 deg down from horizontal.

Payload Accommodation Three main interior configurations have been evolved in the 710 sq ft usable floor area. A 66-seat four-abreast custom interior with six lounge seats (adopted by Eastern), an 85-passenger five-abreast standard interior with a similar lounge, and an 81-seat mixed class interior. American Airlines' 71-seat "living room" has been discontinued. Eastern's interior includes blue seats, blue and gold floors, nuagahyde side panels and mylor-coated hatracks. Cargo compartments under the floor have capacities of 254 and 270 cu ft; and 108 cu ft of carry-on baggage space is provided. Pre-loaded baggage bins, 36in wide, 77in long and 24in deep, made of glass fibre, will be used by American Airlines for loading baggage at the ticket counter.

Convair 880

Convair Division of General Dynamics Corporation, San Diego, Cal.



IN the design of the Convair 880, General Dynamics have aimed primarily at the market for a very fast medium-sized jet—medium-sized in this connection implying a gross weight not far short of 200,000 lb. By starting later than either Boeing or Douglas, the firm have been able to offer an aircraft with greater speed than either of the big jets, although aerodynamic limitations are now such that the increase is marginal; at the claimed cruising Mach number of 0.89 the speed is 615 m.p.h.—almost five per cent faster than, say, the DC-8.

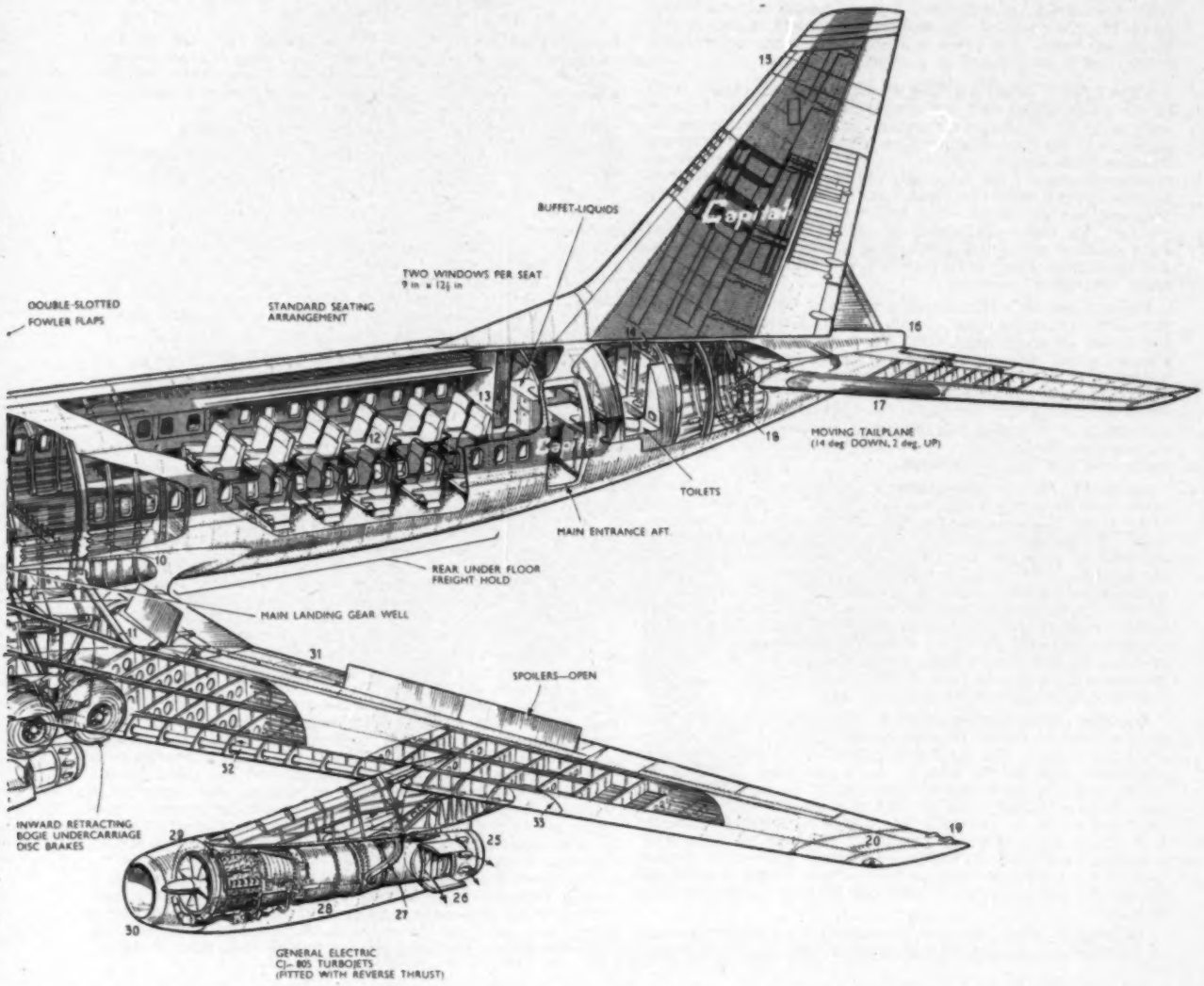
Convair have tooled extensively for 880 production and will have invested some $50m on development. A million square feet of floor space is being devoted to the aircraft and the first one is now well forward and should be rolled out in December this year, prior to its first flight on January 30, 1959. Convair have undoubtedly set themselves a high break-even target to recoup their tooling outlay; but they intend to build all aircraft, including the first, on production jigs.

The company are now also offering to the airlines an increased capacity, larger version of the 880 known as the Convair 600—a curious similarity of designation to the Skylark 600 which preceded the 880 and Golden Arrow. The 600 is reported to have a cruising Mach number of 0.91, a maximum taxi weight of 219,000 lb and a 217,800 lb take-off weight. It would carry 92 passengers in a first-class configuration, 125 tourist or 139 coach. The powerplants have not yet been specified but may be developed versions of the 880's General Electric CJ-805-35s (military variant: J79). Convair are so far the only manufacturer to use this engine in a civil transport.

COMMERCIAL HISTORY The 880 has so far not sold very widely, the only firm orders having been placed by **T.W.A.**, **Delta** and **Capital** for 30, 10 and 9 aircraft, respectively. Two South American carriers, **Transcontinental** (Argentina) and **Real** (Brazil), have expressed intentions of purchase, subject to the arrangement of satisfactory finance. Construction is going ahead and the wing is due to be added this September, the first flight being scheduled for next January. Three aircraft will be used in the certification programme. First delivery (to T.W.A. for training) is planned for November 1959, and commercial services are due to be inaugurated once the aircraft is certificated (scheduled for spring 1960). All existing orders are to be fulfilled before December of that year.

AIRFRAME The layout of the Convair 880 follows typically American practice, with a swept wing (35 deg at 30 per cent chord) and podded engines quite widely separated along the span. Fail-safe design has been given considerable attention throughout; the wing features a three-spar torsion box and multiple load paths, and rip-stop techniques are used extensively throughout the structure. The centre spar is discontinued outboard of the outer engines, but an unbroken trailing edge (the ailerons are placed well inboard) allows the alternative load path principle to

1 Weather radar in bleed-air-heated radome
2 Nosa panels with air-jet slots
3 Main flight-deck air trunk
4 Main cabin air trunk (one each side)
5 Entrance-door locking slots
6 Non-structural bulkhead
7 Stringers absent over wide arc
8 Emergency exit panel each side
9 Skin thickness here 0.1in
10 Tear-stopping doubler
11 Undercarriage spar member
12 50in double seat unit with table
13 Service door and emergency exit
14 Central spar joins pressure dome
15 Structural dielectric insert
16 Slab-sided rear fuselage end-cap
17 Electro-thermal sandwich de-icing
18 Hydraulic nuts running on screw-jack
19 Twin fuel jettison nozzle
20 Integral-tank venting outlet
21 Outboard tank
22 Intermediate tank
23 Forward inner tank
24 Aft inner tank
25 Noise-suppressing nozzle
26 Thrust-reverse doors each side
27 Steel horseshoe frame
28 Rohr-built titanium nacelle
29 Aluminium-alloy section
30 Stainless-steel lip
31 Flipper-type aileron
32 Bleed-air ducting
33 De-icing air space between skins
34 Condenser fan and drive
35 Freon compressor and drive
36 Freon condenser
37 Freon gas evaporator
38 Heat exchanger
39 Cabin-air recirculation and drive fan
40 Supercharger and turbine drive
41 Dihedral of wing proper outboard of root
42 Ram intake to cabin air system each side
43 Ground air conditioning connection (central underneath)
44 Main cabin air trunk from air-conditioning bay
45 Electronics bay beneath floor


BUFFET-LIQUIDS
TWO WINDOWS PER SEAT 9 in × 12½ in
DOUBLE-SLOTTED FOWLER FLAPS
STANDARD SEATING ARRANGEMENT
MOVING TAILPLANE (14 deg DOWN, 2 deg UP)
TOILETS
MAIN ENTRANCE AFT
REAR UNDER FLOOR FREIGHT HOLD
MAIN LANDING GEAR WELL
SPOILERS—OPEN
INWARD RETRACTING BOGIE UNDERCARRIAGE DISC BRAKES
GENERAL ELECTRIC CJ-805 TURBOJETS (FITTED WITH REVERSE THRUST)

be carried through to the extreme tip of the 120ft-span wing.

Fuselage Maximum height and width of the oval fuselage cross-section are 149in and 138in. Hoop stresses are kept to below 8,460 lb/sq in and the skin is everywhere at least 0.063in thick. Frames and stringers are formed from Z sections and at all skin-to-frame joints tear-stopping details are incorporated. Each frame carries a transverse tie-beam supporting the metal sandwich floor.

Convair practice is to use a multiplicity of quite small windows; each one is a 12½in high by 9in wide rectangle with a generous corner radius consisting of three Plexiglass panels supported in a forged light alloy frame. The main passenger entry doors on the port side are of ingenious wedge-shaped design, wider at the top than at the bottom. They are lifted vertically in slotted tracks and then open outward.

Tail Unit The variable-incidence tailplane has distinct dihedral. A two-spar structure passes through the unpressurized tail cone. The fin has three main spars (the middle one is attached to the rear pressure bulkhead) and the top is isolated by a dielectric insert.

Undercarriage The inward-retracting four-wheel bogie main legs and the forward-retracting nose gear are produced by the Cleveland Pneumatic Tool Co. The main legs fold up into a ventral bulge on the underside of the fuselage, which also houses the air-conditioning equipment. Bendix brakes are of the single-disc multi-cylinder pattern with the Hydro-Aire hydraulic anti-skid system; most unusually the nosewheel is included in the braking system. Mainwheel tyres are 44×16in 20-ply nylon inflated to 115 lb/sq in and nosewheel tyres 34×11in nylon 12-ply inflated to 80 lb/sq in. A constant-torque motor steers the lower leg through ±70 deg.

POWERPLANT The Convair 880 is powered by four General Electric CJ-805 single-shaft turbojets, the rating of which will depend upon the development stage but is around 11,000 lb. This engine has a 17-stage compressor of which the I.G.V.s and following six stages of stators have variable incidence. Starting is pneumatic by means of AiResearch equipment for which two Solar gas turbine ground units supply 2,200 cu ft of air/min. Titanium is extensively used in the nacelle cowling, which has

Convair 880 . . .

very large doors on either side. The intake lip, which is thermally de-iced and must withstand impact and abrasion, is manufactured from stainless steel. Within the close-fitting nacelle the engine is supported at three points and reacts the principal loads into a steel forged hoop. A General Electric thrust reverser, ejecting on both sides and a noise suppressing nozzle (generally similar in design to those developed by Rolls-Royce) form part of the installation. The nacelle is slung from anchorages on the wing front spar by a raked-forward pylon. Additional attachment points are at the leading edge and centre (inboard engine) or rear (outboard) spars. The pylon is a fire-sealing structure arranged to shear off in the event of an accident.

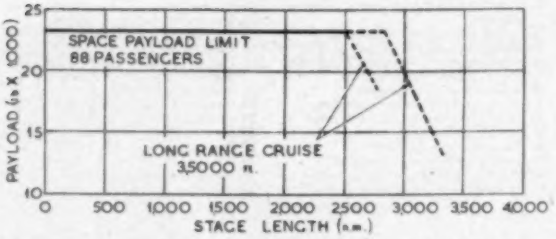
SYSTEMS **Fuel** All fuel is contained in the integral tanks in the wings, sealed with Scotchweld primer and taps. Inboard wing tanks are divided by the centre spar and by a transverse rib outboard of the inner engines from a tank between the engines. Another tank extends outboard to the tip. The total system capacity is about 8,968 Imp. gal, and there are four refuelling sockets through which the tanks can be filled at a rate of 250 Imp. gal/min per socket. The fuel system is pumped at 60 lb pressure by eight Thompson Products engine pumps and eight auxiliary pumps; hydraulic motor-driven pumps provide for fuel jettisoning. Fuel can be carried in the centre section in long-range "overwater" versions.

Flying Controls The Convair 880 uses an almost entirely manual flying control system which has been developed for cruising speeds of about Mach 0.9. The most novel feature is the ailerons which are placed outboard of the inner engines and operated by an aerodynamic tab along the entire trailing edge. Four sections of spoiler ahead of the flaps supplement the ailerons for lateral control, but can also be operated in unison through the commands of a mixing box for rapid let-downs. Rudder and elevators are manually operated by tabs, but the variable-incidence tailplane is hydraulically powered.

Cabin Air Ram air ducted from intakes at the front of a fairing under each wing root is supplied to the cabin by two main engine bleed-driven compressors. The 160 lb/min air supply is sufficient to give a complete change of air every 2½ min and is temperature-adjusted to keep the interior at 75 deg F. Maximum cabin differential pressure is 8.2 lb/sq in, but sea-level cabin altitude is held up to 20,000ft, 6,000ft at 35,000ft and 8,200ft at 40,000ft. An air conditioning systems bay is situated in the ventral bulge under the centre section which houses the retracted undercarriage. Customers may specify either electric or pneumatic refrigeration circuits. In the former case, Freon compressors, recirculating blowers and cooling fans are driven from the main AC supply; otherwise, bleed-air turbine drives are used.

De-icing Wing leading edges are thermally de-iced by compressor bleed-air ducted between double skins which extend over the entire region. The outer skin is chemically milled to provide chordwise paths for the airflow. Air is also used to protect the leading edges of the nacelle and the front of the powerplant. Fin and tailplane leading edges are de-iced electrically by equipment produced by B. F. Goodrich and Canadian Applied Research, Ltd.; the skin is a three-layer sandwich of which the outer layer is stainless steel sheet, the middle layer a plastic-embedded element and an inner layer of light alloy. The windscreen is protected electrically and provision is made for blowing the panels clear of rain.

Hydraulics Four Hamilton Standard pumps supply pressure at 3,000 lb/sq in for operation of the undercarriage, wheel brakes, anti-skid units, flaps, tailplane screw jack adjustment, spoilers, and fuel jettison system. Apart from air starting, there is no associated pneumatic system.



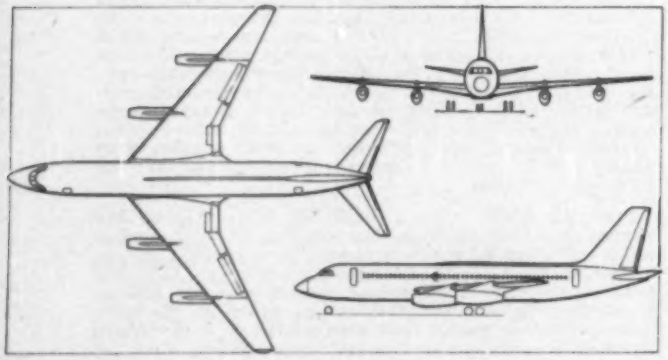
Payload range curves for the 88-seat Convair 880. The full line represents a take-off weight of 178,500 lb and 8,968 Imp. gal tankage, and broken lines 186,500 lb take-off weight and 10,633 Imp. gal tankage. Reserves include two hours holding and 200 n.m. diversion, and still air, I.S.A. is assumed.

Electrics Four 40kVA General Electric alternators provide the main electrical supply at constant 400 c/s frequency for 115 and 200 volt circuits. Constant speed drives are also manufactured by General Electric, and the complete AC generating system is fault-protected and fully paralleled. Four 50 amp transformer rectifier units convert current from the main AC busses to feed a 28V DC system. The latter is also fed by a 24V, 13½ amp hr nickel-cadmium battery.

FLIGHT DECK Cockpit layout—conforming with the latest S.A.E. practice—is fairly conventional. Behind the two pilots' seats is a third swivelling seat adjacent to a wall panel on the starboard side; the normal occupant is likely to be a flight engineer, as demanded for domestic operations by the C.A.A. Weather radar is carried in the nose, ahead of the pressure bulkhead, and most electronic equipment is installed under the cabin floor aft of the nosewheel bay.

PAYLOAD ACCOMMODATION Three standards of accommodation are being suggested by Convair: a high density coach layout carrying 109 passengers, arranged mostly five abreast (21×5 and 1×4); a standard version with 88 first class seats, mostly four abreast at 38in pitch, but with a forward lounge seating 12, and a further variant with no lounge seating 84 four-abreast. Seats are manufactured by National Seating Co. to Convair specifications and the average weight of a double seat is 50 lb. With the first class layout, the double seat unit is 50in wide and there is a 28in aisle. In coach-class seating the double and triple units are 44in and 65in wide respectively and the aisle width is then 28in. The cabin has a maximum width of 120in and is 39ft 3in long. Tip-up seats are provided for three stewardesses and there is a food buffet opposite the forward entrance door and a liquid buffet aft. One toilet, stewardess seat and coat-compartment is positioned forward and there are two toilets and stewardess seats aft; an arrangement that applies to all versions. In the two standard versions coat-hanging space is provided in a central partition to reduce the apparent length; Convair are also experimenting with variations in ceiling height to achieve the same effect.

Between the electronics bay and the air conditioning system is a cargo hold and there is another behind the wing. A total volume of 365 cu ft is devoted to baggage and freight; the rear hold being larger than the front. Air-stairs are not standard equipment, but Convair estimate turn-round time at not more than 25 min.



CONVAIR CV-880

Four General Electric CJ-805-3 turbojets, each rated at 11,200 lb thrust, excluding losses from reverse-thrust and quiet nozzle

Dimensions: Wing span, 120ft; root chord, 35ft 8in; gross area, 2,000 sq ft; dihedral, 7 deg; horizontal tail area, 395 sq ft; vertical tail area, 295 sq ft; overall length of aircraft, 129ft 4in; fuselage overall length, 124ft 2in; ruling exterior width, 11ft 6in; exterior height, 12ft 5in; height to tip of fin, 36ft 0.3in; track, 18ft 10.6in; wheelbase, 52ft 11in.

Weights (domestic version with 88 seats): Empty, 82,100 lb; basic operating weight, with 100 lb oil, 86,200 lb; space-limited payload (passengers, 14,520, baggage 3,520, freight 5,110), 23,150 lb; operating zero-fuel weight, 109,350 lb; maximum weight, 178,500 lb; weight-limited payload, 30,800 lb; maximum landing weight, 132,800 lb; maximum zero-fuel weight, 117,000 lb; maximum weight with centre section fuel tank, 186,500 lb.

Performance (CJ-805-3 engines, 178,500 lb, 100 per cent temp. accountability, obstacle height, 35ft): Take-off field length, 6,930ft at s.l., I.S.A.; landing field length (same conditions, flaps 50 deg, spoilers 60 deg), 6,000ft; range with capacity payload, 2,600 n.m. in l-r. cruise at 35,000ft in normal cruise configuration and thrust; block speed for 2,000 n.m. range in normal cruise for best cost, 445 kt (512 m.p.h.) with 42,000 lb block fuel; maximum cruising speed at 128,000 lb, 615 m.p.h.

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More than 50 Civil Airlines and 30 Air Forces use Marconi radio, radar and navigational aids

MARCONI

AIRCRAFT AND AIRPORT SYSTEMS FOR COMMUNICATIONS AND NAVIGATIONAL AIDS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

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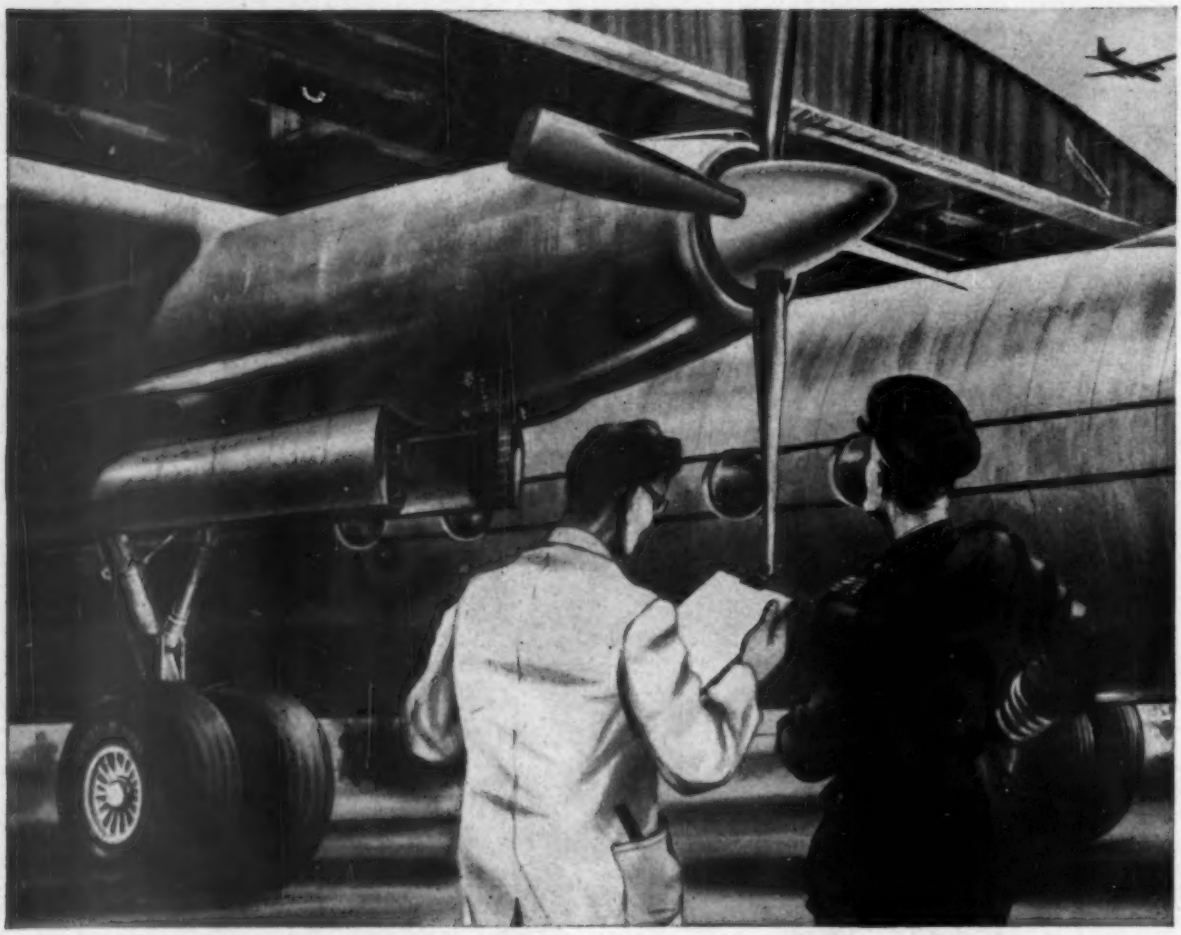


Extra tyre life on the Dart Herald

IN A RECENT searching interview with airline engineers on technical aspects of the new Dart Herald, Mr. John Allan, Dip.Ae. (Hull), A.F.R.Ae.S., Chief Designer of Handley Page (Reading) Ltd., was asked: 'Would you recommend the use of anti-skid brakes?' His reply is given here in full.

"Indeed we would. We have flown both our prototypes with Goodyear anti-skid units operative from the beginning and our tyre lives have benefited considerably from their use.

"Our pilots are sold on this system, and only by a special effort can they make a shorter landing run without anti-skid.

"We have been delighted with the whole performance of our brake system; during recent trials we made over thirty accelerated stop runs at full weight with one set of brake discs."

Goodyear engineers will gladly provide further information on anti-skid systems.

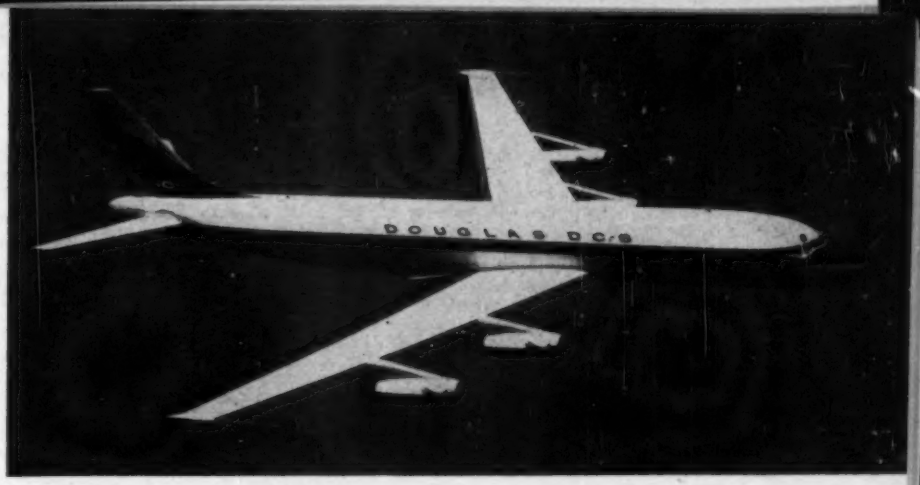
* *Goodyear tyres, wheels, brakes and control equipment are specified for the Herald and Dart Herald.*

GOODYEAR AVIATION DIVISION

SERVING AVIATION THE WORLD OVER

DC-8

Douglas Aircraft Company,
Santa Monica, California



LIKE its Seattle contemporary, the Douglas DC-8 has blossomed into many different versions as its operational scope has been widened. Since the aircraft was first announced, its weight has increased from a maximum of 257,000 lb to a maximum of 310,000 lb, although—unlike the Boeing 707 series—the airframe dimensions have remained unchanged since 1956 and do not vary between domestic and international models. Off to a later start than Boeing and without their competitor's direct military backing, Douglas are determined to show that with their long commercial experience they can produce from their own resources an airframe at least equally good, and in many respects more advanced. Thus Douglas have invested considerably more than $200m in wages, engineering, tools and facilities, including a new building solely for DC-8 assembly.

The magnitude of the task which Douglas have set themselves is illustrated by a slight falling behind schedule which occurred over the first flight target. This took place on May 30, about two months behind the anticipated date; but Douglas are confident that the certification date of October 1959 for the first DC-8s with JT3C powerplants will not be delayed. An unprecedented number of aircraft—four with JT3Cs, three with JT4As and two with Conways—are to be employed on certification trials, and by November 1959 and February 1960 both JT4 and Conway versions should be certificated and production models of each ready for airline deliveries.

There are two basic DC-8 models, which are distinguished by the designations Domestic and Intercontinental. Within this broad division there are six distinct variants. The Domestic versions powered by either Pratt and Whitney JT3C-6s or by JT4A-3s, have a design gross weight of 265,000 lb, and the four Intercontinental versions comprise an aircraft with a gross weight of 287,500 lb with either JT4As or Rolls-Royce Conways, and the same choice of engines in combination with a long-range DC-8 weighing no less than 310,000 lb.

Douglas have studied very intensively the problems of suppressing noise level; the first aircraft to fly was equipped with suppressors designed by Rolls-Royce but Douglas have invested $4m and 360,000 engineering man-hours of their own. The final design will include a clam-shell type thrust reverser as part of the suppressor unit.

COMMERCIAL HISTORY The first DC-8 order was placed by **PanAm,** who bought 25 in October 1955. Later, this order was revised so that four aircraft would go to Panair do Brasil and another four to Panagra in 1960, leaving PanAm 17 to be delivered in 1959 and 1960.

The following subsequent orders have brought DC-8 sales to 147: **United,** 40 (originally 30) in October 1955; **National,** 6 in November 1955; **K.L.M.,** 8 in November 1955; **Eastern,** 20 (originally 18) in December 1955; **Japan Air Lines,** 4 in December 1955; **S.A.S.,** 7 in December 1955; **Swissair,** 3 in January 1956; **Delta,** 8 in May 1956; **T.C.A.,** 6 with Conways in May 1956; **U.A.T.,** 2 in November 1956; **T.A.I.,** 2 in November 1956; **Olympic,** 2 in July 1957; **Trans-Caribbean,** 1 in January 1958; **Alitalia,** 6 with Conways in March 1958; **Iberia,** 2 and **Northwest,** 5 (these last two orders not yet having been finalised). Domestic models of the DC-8 are due for delivery in the latter part of 1959, while the international versions will be delivered through 1960 and 1961.

AIRFRAME The structure of the DC-8 is relatively sophisticated; advanced bonding and riveting techniques, titanium panelling, roll-tapered light alloy skinning and rip-stop construction techniques are widely used. Strict limits have been set on stress levels, with particular emphasis on the elimination of stress concentrations. Adherence to the philosophy of alternative load paths is illustrated by the third spar introduced into the wing torsion box.

Fuselage Geometrically the double-bubble section is formed from a 73.5in upper radius and 68.7in lower. The untapered portion is nearly 100ft long. Lap-jointed skin panels are laid over z-section stringers riveted to channel frames at 20in pitch. All doors are of a Douglas design and are double hinged, so that a plug type arrangement can be used but the door can be lifted inwards and slid out edgeways. Cargo doors are mounted on tracks and slide upwards and inwards. The windows are also of unusual shape, the low sides being formed from arcs that give dimensions of 16in high by 14in wide at the major and minor axes; the four arcs are joined by a smaller radius.

Wing An unusual profile has been adopted which changes radically from root to tip, but allows a 30 deg sweep to be adopted and postpones the drag rise. All three main spars have heavy sheet webs carrying vertical stiffeners, and are arranged to lie so that outboard of the outer engines, where the bending moment is low, front and centre spars converge to leave a two-spar arrangement out to the tip. The wings are joined on the aircraft centre line with a butt strap and are then continuous to the tip; a manufacturing break is provided but is not intended to be broken down after the aircraft is complete. The box formed between the front and rear spars, Y-section compression stringers, I-section lower stringers and skins is an integral fuel tank where the ribs act as fuel baffles. The three-spar construction of the wing is continued in the fin and tailplane. The latter has a three-plank integrally stiffened structure between front and rear spars and much of the skin is stabilized by bonding. The fin is remarkable chiefly for the 8ft of glassfibre structure (including spars) which forms the dielectric tip. The engine pylons sweep inwards, following the spanwise flow, and the two main spars pick up on a stiff rib between the front and rear wing spars. The complete assembly is built by Ryan and the pod access doors and pylon trailing edges are entirely panelled in titanium.

Undercarriage Each forged main leg carries an articulated four-wheeled bogie, which allows the aircraft to be pivoted about a point 4.5ft from the inside gear. The undercarriage track is 20ft 9½in. Bendix main and nose wheels are shod with Goodyear or other manufacturers' tyres inflated to 131 lb/sq in for aircraft with a maximum weight of 287,000 lb. Nose wheel tyres are 34×11in and mainwheel tyres 44×16in. All undercarriage legs are arranged to fall by gravity in the event of hydraulic failure and the main legs are covered by three doors when retracted; the main door enclosing the wheels is closed when the undercarriage is down.

Rudder pedals are used to steer the nose undercarriage up to 10 deg from centre, and a handwheel for 78 deg thereafter. When the nosewheel has been swivelled through 40 deg, the articulated main gear bogie can be unlocked for taxying.

POWERPLANT A choice of three engines is offered: Pratt and Whitney JT3C-6s with a wet rating of 13,400 lb for the domestic variant and JT4As or Rolls-Royce Conways for the Intercontinental. JT4A-3s, with a dry rating of about 17,000 lb thrust, or Conway 507s with a dry rating of 16,500 will be used with the 287,500 lb airframe, but the long-range aircraft will use the higher powered JT4A-9s or Conway RCo.12s. Provision is made for 350 gal of water to be carried in the wing tips and centre section and a 10kVA drive powers the associated water injection pump. The first DC-8 to fly was equipped with a Greatrex-type noise suppressor of Rolls-Royce design, but later models will adopt a combined silencer/clam-shell door thrust reverser which Douglas have been developing; the company have invested heavily in research to obtain suitable equipment.

SYSTEMS **Fuel** Intercontinental and Domestic versions differ in that, in the latter, the inboard end of the integral tank terminates outboard of the centre line of the fuselage. Respective capacities are 18,000 Imp. gal and 14,650 Imp. gal, but the 310,000 lb Intercontinental aircraft carries 19,400 Imp. gal total fuel. The integral tank is divided at the manufacturing joint into main and auxiliary sections and each engine has its own fuel and tank system with inter-connecting crossfeed. Pressure refuel-

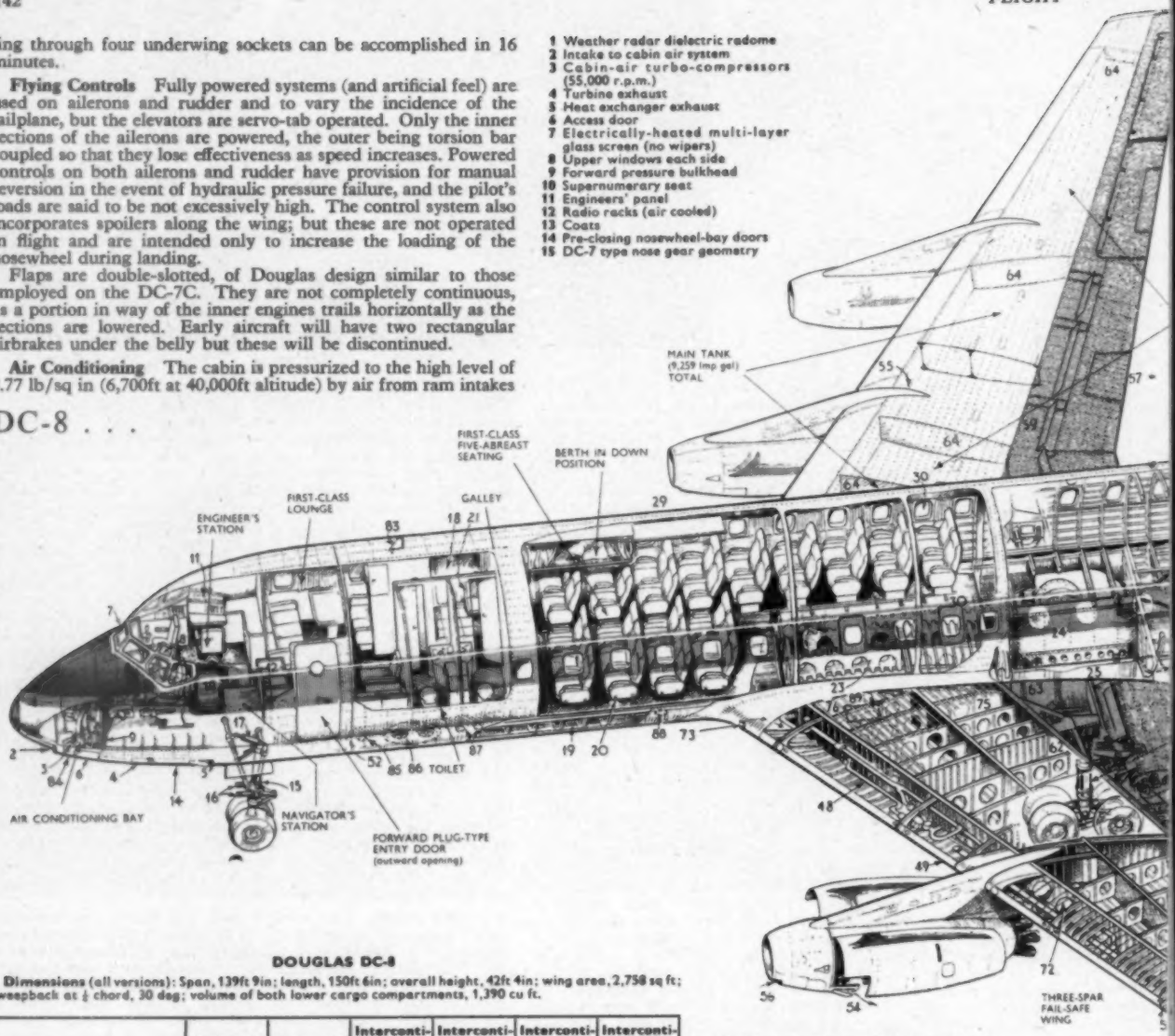
ling through four underwing sockets can be accomplished in 16 minutes.

Flying Controls Fully powered systems (and artificial feel) are used on ailerons and rudder and to vary the incidence of the tailplane, but the elevators are servo-tab operated. Only the inner sections of the ailerons are powered, the outer being torsion bar coupled so that they lose effectiveness as speed increases. Powered controls on both ailerons and rudder have provision for manual reversion in the event of hydraulic pressure failure, and the pilot's loads are said to be not excessively high. The control system also incorporates spoilers along the wing; but these are not operated in flight and are intended only to increase the loading of the nosewheel during landing.

Flaps are double-slotted, of Douglas design similar to those employed on the DC-7C. They are not completely continuous, as a portion in way of the inner engines trails horizontally as the sections are lowered. Early aircraft will have two rectangular airbrakes under the belly but these will be discontinued.

Air Conditioning The cabin is pressurized to the high level of 8.77 lb/sq in (6,700ft at 40,000ft altitude) by air from ram intakes

DC-8 . . .



1 Weather radar dielectric radome
2 Intake to cabin air system
3 Cabin-air turbo-compressors (55,000 r.p.m.)
4 Turbine exhaust
5 Heat exchanger exhaust
6 Access door
7 Electrically-heated multi-layer glass screen (no wipers)
8 Upper windows each side
9 Forward pressure bulkhead
10 Supernumerary seat
11 Engineers' panel
12 Radio racks (air cooled)
13 Coats
14 Pre-closing nosewheel-bay doors
15 DC-7 type nose gear geometry

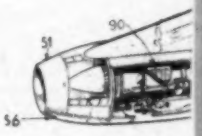
DOUGLAS DC-8

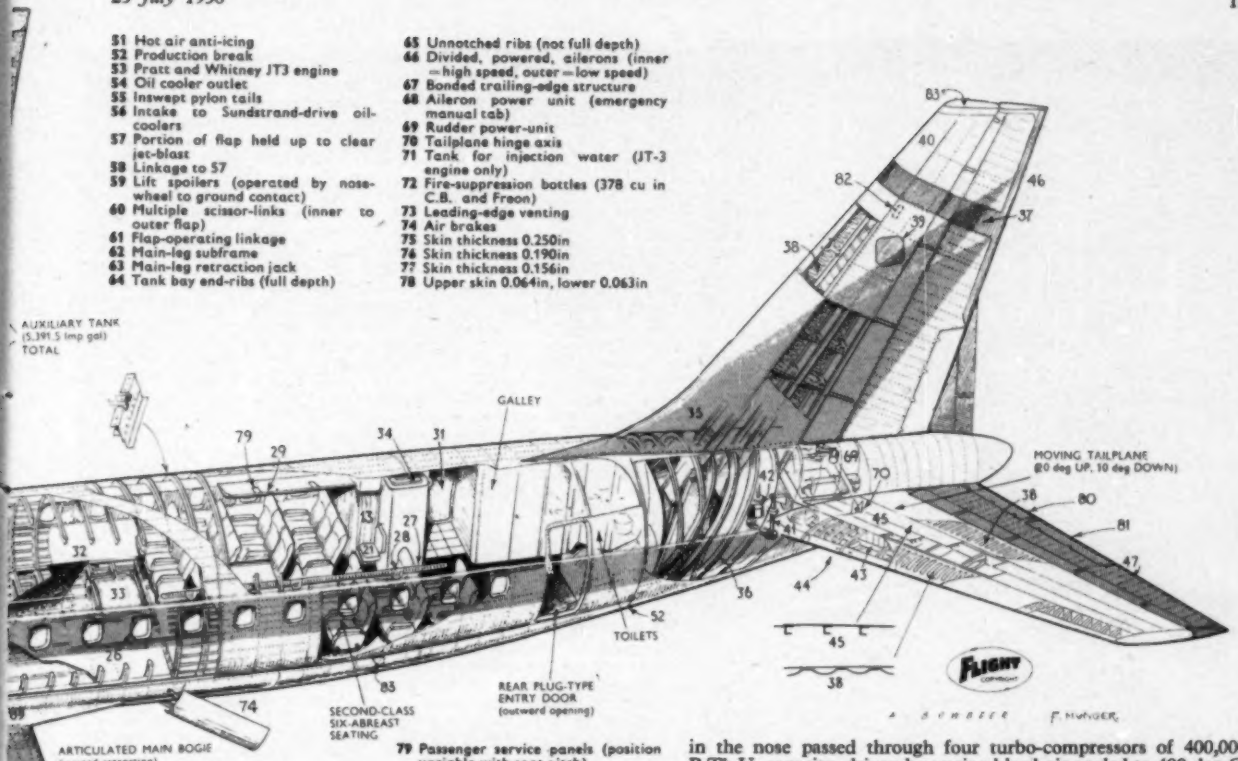
Dimensions (all versions): Span, 139ft 9in; length, 150ft 6in; overall height, 42ft 4in; wing area, 2,758 sq ft; sweepback at ¼ chord, 30 deg; volume of both lower cargo compartments, 1,390 cu ft.

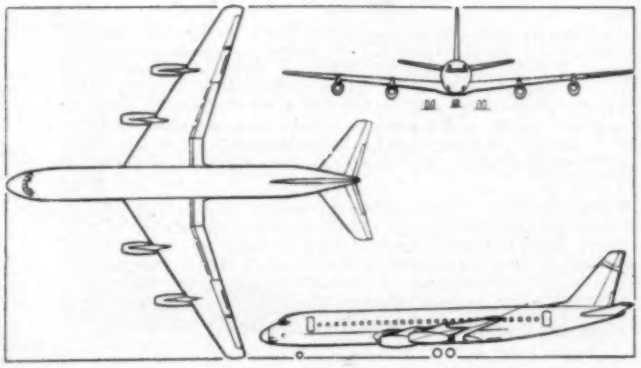
	Domestic JT3C-6	Domestic JT4A-3	Intercontinental JT4A-3	Intercontinental Conway	Intercontinental JT4A-9	Intercontinental Conway
Weights:						
Gross weight (lb)	265,000	265,000	287,500	287,500	310,000	310,000
Max. usable T.O. weight (lb)	265,000	265,000	287,500	287,500	310,000	310,000
Landing weight (lb) ...	189,000	189,000	194,000	194,000	199,500	199,500
Operating weight empty (lb)	122,698	124,977	130,092	128,082	132,310	130,164
Zero fuel weight (lb) ...	161,200	164,550	170,550	168,650	176,500	174,600
Freight (lb)	13,900	13,900	13,900	13,900	13,900	13,900
Space limited capacity payload (lb) first-class ...	33,040	33,040				
Space limited capacity payload (lb) mixed-class ...			35,680	35,680	35,680	35,680
Space limited capacity payload (lb) tourist ...	37,165	37,165	37,165	37,165	37,165	37,165
Performance:						
Level flight speed max. cruise T.A.S. (m.p.h.) 30,000ft at 220,000 lb ...	561	589	589	591	588	590
C.A.A. T.O. field length (ft) max. T.O. weight ...	9,170	7,320	8,430	8,470	9,220	9,050
C.A.A. landing field length (ft) max. landing weight	6,680	6,630	6,850	6,850	7,100	7,100
Range with 6,500ft T.O. field length, first-class version (st. m.)	2,340	3,710				
Range with 6,500ft T.O. field length, mixed-class version (st. m.)			3,240	3,380		
Range with 6,500ft T.O. field length, tourist version (st. m.)	2,040	3,420	3,140	3,280		
Range, first-class (st. m.)...	3,900	4,100				
Range, mixed-class (st. m.)			4,500	4,680	5,030	5,200
Range, tourist-class (st. m.)	3,600	3,800	4,390	4,580	4,930	5,100

Allowances include noise suppressor, pre- and post-flight fuel, climb, descent, 300 miles reserve and one hr hold at 1.1 Vmd at 15,000ft.

16 Steering cylinders (10 deg each way with rudder, 78 deg by hand-wheel)
17 Retraction jack
18 Galley service door
19 Underfloor hold (door starboard)
20 Wall-fixed slots
21 Attendant's seat
22 Centre-joint butt-strap
23 Centre section tank ("overwater" model only)
24 Centre keel-member (5ft deep)
25 Mainwheel doors (normally closed after undercarriage extension)
26 Windows (18½ × 15in)
27 Cabin air in: out at floor level
28 Passenger-address speaker
29 Hat racks
30 Emergency exits
31 Emergency doors
32 "Hot wall" panelling
33 Inward-opening freight door
34 Concealed lighting
35 Integral three-spar fin
36 Sloping frames
37 Fibreglass (dielectric) structural isolation
38 Bonded inner skin
39 V.O.R. aerial
40 H.F. aerials (1 and 2)
41 Tailplane screw-jacks
42 Tailplane hydraulic and electric motors
43 Tail de-icing trunk
44 Retractable bumper
45 Integrally-stiffened skin
46 Fully-powered rudder
47 Manual elevators
48 Fuel system runs
49 De-icing duct (cyclic heat)
50 De-icing trunk




51 Hot air anti-icing
52 Production break
53 Pratt and Whitney JT3 engine
54 Oil cooler outlet
55 Inswept pylon tails
56 Intake to Sundstrand-drive oil-coolers
57 Portion of flap held up to clear jet-blast
58 Linkage to 57
59 Lift spoilers (operated by nose-wheel to ground contact)
60 Multiple scissor-links (inner to outer flap)
61 Flap-operating linkage
62 Main-leg subframe
63 Main-leg retraction jack
64 Tank bay end-ribs (full depth)
65 Unnotched ribs (not full depth)
66 Divided, powered, ailerons (inner—high speed, outer—low speed)
67 Bonded trailing-edge structure
68 Aileron power unit (emergency manual tab)
69 Rudder power-unit
70 Tailplane hinge axis
71 Tank for injection water (JT-3 engine only)
72 Fire-suppression bottles (378 cu in C.B. and Freon)
73 Leading-edge venting
74 Air brakes
75 Skin thickness 0.250in
76 Skin thickness 0.190in
77 Skin thickness 0.156in
78 Upper skin 0.064in, lower 0.063in
AUXILIARY TANK (5,391 S Imp gal) TOTAL
GALLEY
MOVING TAILPLANE (20 deg UP, 10 deg DOWN)
TOILETS
REAR PLUG-TYPE ENTRY DOOR (outward opening)
SECOND-CLASS SIX-ABREAST SEATING
ARTICULATED MAIN BOGIE (inward retracting)
DOUBLE-SLOTTED DOUGLAS FLAPS
SINGLE SKIN FROM C/L TO PRODUCTION BREAK
79 Passenger service panels (position variable with seat pitch)
80 Control tab
81 Geared tab
82 H.F. Antenna coupler and lightning arrester
83 V.H.F. aerials (three)
84 Glide-slope aerial
85 D.M.E. aerial
86 A.D.F. aerials
87 Transponder
88 Radio altimeter aerial
89 A.D.F. sense aerials (four)
90 Oil tank
91 Rolls-Royce noise suppressors
FLIGHT



in the nose passed through four turbo-compressors of 400,000 B.Th.U. capacity, driven by engine bleed-air cooled to 400 deg C. Any compressor can maintain full cabin pressure; the airflow capacity is 234 lb/min at sea level, 166 lb/min at cruising altitude. A closed circuit Freon refrigeration system is installed. Warm air is ducted into trunks in the cabin roof and wall as the radiant heat source and enters the cabin beneath the luggage racks. After circulation it is ejected through a propelling nozzle on the ventral centreline—due to the input of heat from the cabin, a small net thrust gain is possible.

The hot air supply is also used to feed the "blow-away jets" that clear the runway of debris beneath the engines.

De-icing Ice protection is thermal throughout, engine bleed-air being ducted through multiple branch manifolds between the double skins on the leading edges of the wings, tailplane and engine pylons. Hot air is also used for blast rain removal on the flight deck windscreens.

Hydraulics Two engine-driven variable displacement pumps supply Skydrol 500 fluid at 3,000 lb/sq in pressure. The system operates undercarriage, flaps, spoilers, speed brakes, wheel brake, nosewheel steering, engine starting air compressor, tailplane trim and flying controls. An electric pump supplies emergency power.

Electrics The 115/208-volt three-phase 400 c/s AC system is powered by an alternator on each engine driven by a Sundstrand constant speed drive. DC requirements are looked after by four 25 amp transformer-rectifier units.

Radio and Radar Standard equipment includes duplicated H.F. and V.H.F. communication, duplicated A.D.F. and glide slope, marker beacon, Loran, radar transponder, radio altimeter, flight interphone and public address systems. Most aerials are suppressed, the fin incorporating V.O.R. windows, and the upper part of the whole tail forms an aerial of the correct impedance and radiation. Search radar is housed in the heated glassfibre nose dome.

CREW ACCOMMODATION Standard crew consists of a captain, first officer, flight engineer and a supernumerary if required. The Intercontinental aircraft has an additional seat for a navigator.

PAYLOAD ACCOMMODATION By mounting both seats and partitions on standard rails a wide variety of layouts is available in the 7,210 cu ft cabin volume. DC-8 interiors are planned with passenger service panels and "over-the-shoulder" reading lights in the seats, but even at 40in spacing—where each seat is adjacent to a window—140 tourist passengers can be accommodated six abreast; maximum in a coach-class interior is 176. Aisle headroom is 7ft 2in and width is 19in in the standard layout and 16in in the coach interior. There are four or six toilets, depending upon customers' requirements. Freight and baggage holds under the floor total 1,415 cu ft; payload volume is 7,345 cu ft.

Boeing 707

Boeing Airplane Company, Seattle, Washington

RAPID progress has been made at Seattle since the first production Boeing 707 flew from Renton on December 20 last year. The second aircraft—a 707-120 destined for PanAm—made its first flight two months later and C.A.A. certification, which started with tests on the first three production aircraft, began on April 16 and was due to be completed this month.

Thus with a hustle that is typical of its manufacturer, the 707 is being worked up for the start of scheduled services. First off the mark will be PanAm, taking advantage of the pace of Boeing's development to introduce their first Boeing 707-120 on scheduled Transatlantic services perhaps as early as November 1, while they have already mentioned the possibility of bringing a 707 to Europe in August. If there is a lesson to be drawn from this rate of progress, it is that the maximum amount of rig testing is little substitute for aircraft in the air, and experience with the 367-80 prototype (flying since July 1954) and well over 100 KC-135 jet tankers enabled Boeing to aim for completion of the certification programme by this summer—not a long period for an aircraft that is some 200 m.p.h. faster than those that it will replace.

Variants of the 707, each adjusted to suit the needs of particular airlines, has resulted in a family of associated types. Broadly, there are only two basic models: the 707 Stratoliner and the 707 Intercontinental. On these two types, variations in the powerplant and length of fuselage account for a total of five different model designations. The Stratoliner has in every case the "small" (2,433 sq ft) wing but may have Pratt and Whitney JT3C-6 engines (707-120), Pratt and Whitney JT4A-3 (707-220), or Rolls-Royce Conway 505s when it becomes the 707-520, although none of the last-named has yet been ordered. In addition—and this feature is reflected only in the last digit of the designation number which specifies the customer—two fuselage lengths are available, resulting in overall lengths of 134ft 6in ("short body") or 144ft 6in ("long body").

The second of the basic types, the Intercontinental or overwater 707, intended for non-stop long range operations, is longer and heavier than the Stratoliner. (PanAm will be using -120s for Atlantic services at first, for the prestige and traffic value of introducing early jet services, but they may be expected to convert to 707-320s as they become available.) The first -320 is now in final assembly and will undergo C.A.A. tests before being delivered to the airline in 1959. All aircraft of this series feature the large (2,892 sq ft) wing and a maximum take-off weight of 295,000 lb (296,000 is permitted during taxying). Two designations, relating to the engine type, define the sub-divisions of this series. The Boeing 707-320 is an Intercontinental with JT4A-3s and the 707-420 is powered by Rolls-Royce Conways. As with the domestic Stratoliner aircraft, there is a choice of two fuselage lengths associated with the -320 and -420. The shorter is dimensionally similar to the longer fuselage of the 707-120. The longest fuselage of the three sizes is extended 80in over that of the intermediate length. All fuselages have a maximum external width of 148in.

Recently a new version of the Pratt and Whitney JT4—the JT4A-10—has been introduced and it is logical to anticipate that it will be specified for Intercontinental Boeing 707s, possibly accompanied by an increase in fuel capacity and in allowable maximum weight to top the 300,000 lb mark.

BOEING 720

Third of the Boeing 707 family is the Boeing 720. This aeroplane has previously been designated Boeing 717 and Boeing 707-020, but has now been distinguished to underline the fact that it meets a very different specification from the 707 series. While Boeing 707s of all categories are long-range aircraft, the 720 is designed for operation over ranges of 150 to 1,500 miles—the short and medium stages of the range spectrum.

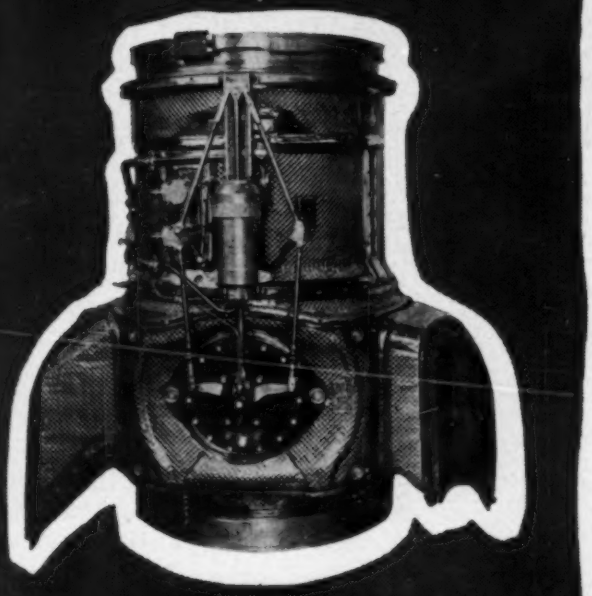
Since less fuel is needed over the 720's operating range, a lower gross weight and a considerably lighter airframe have been made possible. Savings have been achieved in the wing, fuselage and landing gear, and at a gross weight of 203,000 lb (the corresponding weight for the short body -120 is 248,000 lb) the take-off field length performance has been reduced to 6,600ft. Boeing has attempted to achieve with the 720 as many features in common with the 707 as possible, while still producing an aircraft exactly tailored to the function of a medium jet and competing with the Convair 880. Since last November, the basic sales price has been slightly reduced to $3.4m—a very competitive figure.

COMMERCIAL HISTORY With 168 firm orders to hand, equivalent in value to near $1,000m, Boeing head the list of those selling turbojet transports. Although their 707 project moved under way in 1952 and the first flight took place in 1954, it was only in July 1955 that Air Force permission was obtained to manufacture transports concurrently with the KC-135 tankers upon whose design the 707 was based. **PanAm's** historic order for 20 Boeing 707s, together with 25 DC-8s, was placed in October 1955.

In the next two months three domestic trunk carriers placed orders for delivery in 1959-60: **American** for 30 (123s); **Braniff** for 5 (227s); **Continental** for 4 (124s). By December Douglas had broken into the international field with DC-8 sales to K.L.M., J.A.L. and S.A.S. Boeing countered by producing a new design, the Intercontinental 707-320 of which 12 were purchased by **PanAm**. Foreign airlines could now no longer afford just to look on, and before the year-end sales had been contracted with **Air France** for 10 (328s) and **Sabena** for 3 (329s). Early in 1956 **PanAm** realized the challenge of jet competition on intercontinental routes and changed the Boeing order once again, reducing the number of 121s to 6 (delivery in 1958-59) and increasing the number of 321s to 17 (delivery in 1959-60). During 1956 five new carriers purchased 707s: **T.W.A.**, 8 (131s) in February for delivery in 1959; **Lufthansa**, 4 (430s) in April for delivery in 1960-61; **Air-India**, 3 (437s) in August for delivery in 1960; **Qantas**, 7 (138s) in September for delivery in 1959; **B.O.A.C.**, spurred by the prospect of jet competition on both Commonwealth and Atlantic routes, 15 (436s) in October for delivery in 1960.

Over the last two years the incoming flow of orders from new customers has slowed down to 18 aircraft for four carriers: **Cubana**, 2 (139s) in June 1957; **Varig**, 3 (441s) in September 1957; **United**, 11 (720s) in February 1958; **S.A.A.**, 3 (320s) in February 1958—most of these being due for delivery in 1960. In addition to these, three previous customers increased their orders; Air France from 10 to 17; Sabena from 3 to 5; and, most valuable of all, if finally verified, T.W.A. from 8 (131s) to 15 (131s) and 18 (331s).

STRUCTURE Structurally, the Boeing 707 is largely conventional and changes in scale and detail only are made between variants. Extensive use is made of crack stoppers and alternative load paths to achieve fail-safety, but techniques such as integrally milled skins, spot welding or titanium panelling are sparsely



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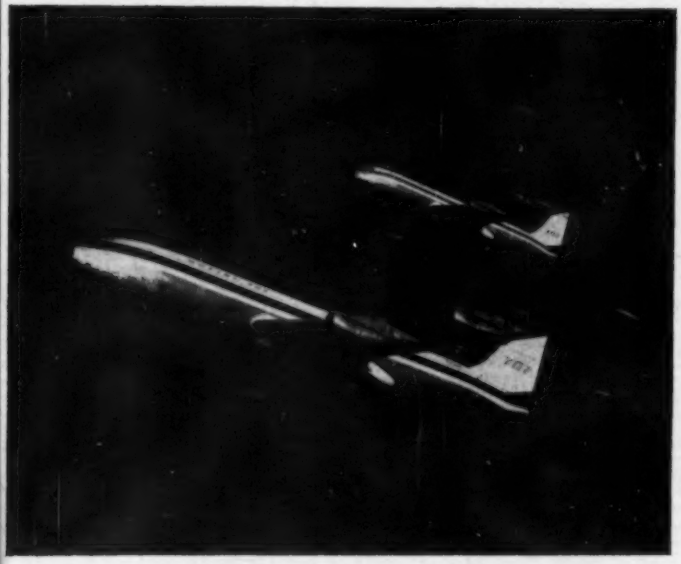
Boeing 707 . . .



Higher echelon: two early production Boeing 707-120s.

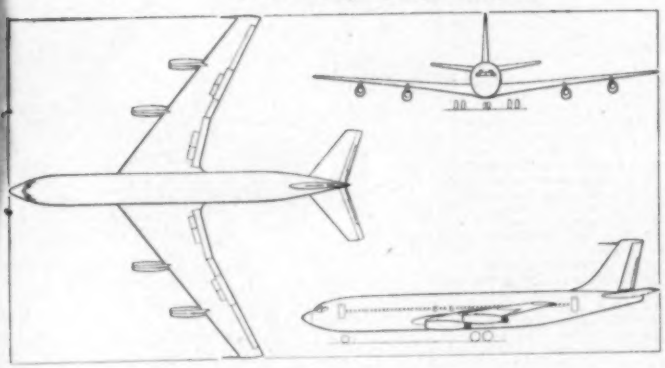
employed. The detailed description which follows applies to the Boeing 707-420, but reference is made to other variants where major differences occur.

Fuselage The three main sections of fuselage—nose, main cabin including the centre section, and tail cone carrying the tail unit—are joined with tension bolts. Semi-monocoque construction is employed embodying Z-frames at 20in spacing and top hat section stringers spot-welded to the skins. Heavy extruded frames are used at the wing spar stations and these are attached to the spars with forgings, so that the wing centre section is a permanent part of the centre fuselage. Transverse tie booms at the intersection of the upper and lower bubble radii form the basis of the floor structure everywhere except over the wing, where the floor is formed as part of the wing structure.

There are a multiplicity of rectangular 9in by 12½in passenger windows—54 on the port side of the fuselage—with two outward opening plug-type entry doors measuring 34in wide and 72in high on the port side and two 24in by 48in galley service doors on the starboard side. Cargo doors, all of the sliding plug type, are positioned opposite on the starboard side; the forward cargo door measures 48in × 50in and the two aft cargo doors measure 48in × 49in and 30in × 35in respectively. The first movement of the passenger door handle reduces the height of the door so that it can pivot and slide out edgeways through its opening. Inward-opening escape hatches measuring 20in × 38in are located between the frames of the 23rd and 27th windows from the front. The specification states that the passenger cabin floor shall be resistant to the impact of high-heel shoes and absorption of water.

Wing The five-part wing consists of a centre section, inboard wing panels and outboard panels including removable tips. The

General arrangement of the 707-320.



main and inboard sections form a common structure with the fuselage and are not detachable. The primary structure consists of two widely spaced spars forming a box with rib-supported upper and lower skins stiffened with extruded stringers. The spars largely carry the shear loads while bending loads are reacted in the skins.

Tail construction is unexceptional. Each half of the variable incidence tailplane is bolted to a centre section box free to tilt in a rectangular cut-out in the fuselage. This is bolted to a pair of forged trusses hinged along a transverse axis behind the rear spar. Metal bonding is used for the attachment of stringers to skin throughout the tail construction, and bonded metal honeycomb is used for the control surface tabs.

The nacelle pods are slung from heavy ribs located diagonally to the inter-spar ribs and from a forging on the front spar. Structural fuses are incorporated in the pylon attachment to prevent damage to the wing during a belly landing; they allow the engine nacelle to break free.

Undercarriage The main legs, each carrying a four-wheel bogie, are mounted between "beaver tail" members overhanging the rear spar and bolted to a strong inter-spar rib. They are retracted inwards by hydraulic jacks. Tubeless tyres of 46 × 16in size are mounted on 17.00 × 20in wheels and inflated to pressures varying between 128 lb/sq in and 145 lb/sq in, depending upon the design weight. The Boeing 720, which has a similar but lightened undercarriage, carries 40 × 14in tyres on the main bogies. An anti-skid braking system is standard equipment in each case.

The nose undercarriage has a dual wheel axle supported by a vertical oleo which retracts forward. It carries 39 × 13in tubeless tyres and is steered by twin cylinders through 60 deg either side of centre. This gives a turning radius of 21ft about the inner bogies.

POWERPLANT As outlined in the introduction, there is no standard powerplant. The -120 is equipped with Pratt and Whitney JT3C-6s, and the 720 with lighter Pratt and Whitney JT3C-7s; the -220, the so-called "hot rod" ordered by Braniff, features JT4A-3s married to the Stratoliner airframe. This engine is also installed in the -320. The -420 and -520 are both powered with Conway 505s with a take-off static thrust at sea level I.S.A. of 16,500 lb. The first aircraft to fly were -120s powered by four JT3C-6s of 13,000 lb thrust wet. This engine is the commercial variant of the military J57 with tandem compressors, can-annular combustion chamber and most of the accessories grouped under the casing of the rear high-pressure compressor. A 5.75 gal oil tank is slung above the front low pressure compressor casing and oil coolers low on each side of the nacelle. About 700 gal water is available for injection at ambient temperatures in excess of 40 deg F. Engine starting is by pneumatic means, three engines being started from the first started by ground supply. Inboard engines on the Boeing 720 are fitted with in-line combustion starters. All engines are fitted with a combination noise suppressor and thrust reverser.

SYSTEMS **Fuel System** Total 420 capacity is 17,653 Imp. gal. Apart from 6,429 Imp. gal contained in the centre section bag tank, fuel is contained in integral cells within the wing box which is divided from root to tip into main tank No. 1, main tank No. 2, and a reserve tank. The capacities are respectively: 3,305 Imp. gal, 1,946 Imp. gal, 361 Imp. gal. In the 720 no fuel is carried inboard of the wing to fuselage support ribs and the total capacity is 8,403 Imp. gal (11,221 Imp. gal optional). Each tank is fitted with a transistorized capacitance-type fuel gauge, dripsticks and 3.0in diameter fuelling ports, and provision is made for underwing refuelling at 50 lb/sq in through four sockets. All main tanks can be refuelled at rates in excess of 180 Imp. gal/min. Fuel dumping arrangements permit one per cent per minute of the maximum take-off weight to be off-loaded down to a minimum of 15,000 lb fuel. For 707-120 capacities see drawing.

Flying Controls Internal balance plates, aerodynamic tabs, inboard and outboard ailerons (the latter operate only when the flaps are down) and spoilers are the basis of the Boeing 707's mainly manual control system, which also provides proportional feel, but rudder boost is used on the 707-220 and Intercontinental models for maximum rudder deflection in the low-speed, engine-out case. The spoilers are actuated hydraulically and are used differentially as aileron assisters or together as air brakes.

Double slotted flaps are divided into inner and outer portions along the wing with simple fillet flaps at the wing root. A hydraulic motor and torque tube actuates the inner flaps and an independent system the outer. Emergency operation is provided by an A.C. electric motor.

Cabin Air Systems Air drawn from ram air intakes above the main air intake is passed through multiple compressors powered by second-spool bleed air and passed into the cabin at a rate of 3,200 cu ft/min at all altitudes up to 40,000ft. The cabin dP is 8.6 lb/sq in between 22,500 and 40,000ft and the temperature and humidity are controlled by an air cycle cooling unit (a vapour-cycle unit is specified by certain customers) and primary heat exchanger cooled by ram air drawn from fairings over the nose-

wheel bay, a secondary exchanger and a water separator. On the ground the system will cool the cabin to 15 deg F below ambient. An eight-inch ground connection is provided near the wing root. A supplemental oxygen supply is provided for both crew and passengers.

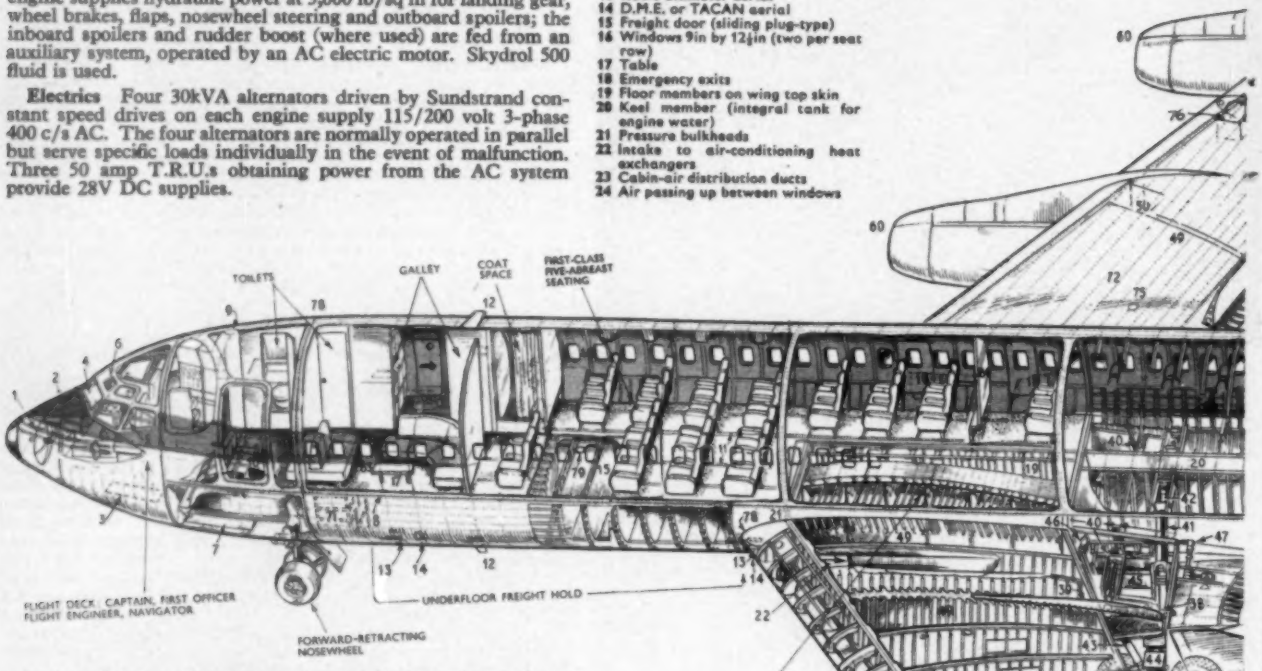
Ice Protection First-spool bleed air is used to de-ice the wing leading edges and the nose cowls are de-iced by second-spool bleed. Tail surface leading edges are protected electrically by 400 c/s 115 volt AC power, and electric heating is also applied to the pitot head. Windscreens and 80 per cent of the side windows are Nesa glass with an electrical power input of 675 watts/sq ft and 475 watt/sq ft respectively. The "eyebrow" windows and aft side windows in the control cabin are similarly de-iced.

Hydraulics A variable displacement piston-pump on each engine supplies hydraulic power at 3,000 lb/sq in for landing gear, wheel brakes, flaps, nosewheel steering and outboard spoilers; the inboard spoilers and rudder boost (where used) are fed from an auxiliary system, operated by an AC electric motor. Skydrol 500 fluid is used.

Electrics Four 30kVA alternators driven by Sundstrand constant speed drives on each engine supply 115/200 volt 3-phase 400 c/s AC. The four alternators are normally operated in parallel but serve specific loads individually in the event of malfunction. Three 50 amp T.R.U.s obtaining power from the AC system provide 28V DC supplies.

Boeing 707 . . .

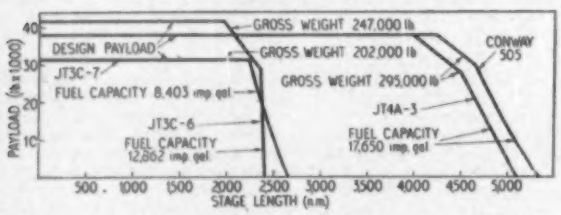
1 Cloud/collision radar scanner
2 Glide-slope aerial
3 Doppler aerial
4 Nesa-glass windscreens
5 Direct-vision panel (slid to rear)
6 "Eyebrow" windows
7 Nosewheel doors shut with gear down
8 "Double bubble" intersection line
9 A.T.C. transponder aerial
10 Nosewheel box
11 Seat tracks (1in increment)
12 V.H.F. aerial
13 Radio altimeter aerial
14 D.M.E. or TACAN aerial
15 Freight door (sliding plug-type)
16 Windows 9in by 12½in (two per seat row)
17 Table
18 Emergency exits
19 Floor members on wing top skin
20 Keel member (integral tank for engine water)
21 Pressure bulkheads
22 Intake to air-conditioning heat exchangers
23 Cabin-air distribution ducts
24 Air passing up between windows


TOILETS
GALLEY
COAT SPACE
FIRST-CLASS FIVE-ABREAST SEATING
FLIGHT DECK: CAPTAIN, FIRST OFFICER, FLIGHT ENGINEER, NAVIGATOR
FORWARD-RETRACTING NOSEWHEEL
UNDERFLOOR FREIGHT HOLD
CENTRE-SECTION FUEL 6,100 Imp gal
INNER INTEGRAL FUEL TANK 1,894 Imp gal EACH SIDE
PRATT AND WHITNEY JT3C-4 TURBOJET. 13,000 lb THRUST
OUTER INTEGRAL FUEL TANK 1,946 Imp gal EACH SIDE
OUTER (RESERVE) FUEL TANKS 361 Imp gal EACH SIDE

Radio and Radar Standard equipment includes a Bendix PB-20 auto-pilot, Collins V.H.F., H.F., Bendix A.D.F. and marker beacon receiver, Collins glide slope receiver and V.O.R., an A.T.C. transponder, R.C.A. A.V.Q.-10 weather radar, radio altimeter and Loran equipment. A fin-tip probe aerial, stub aerials and flush aerials are used.

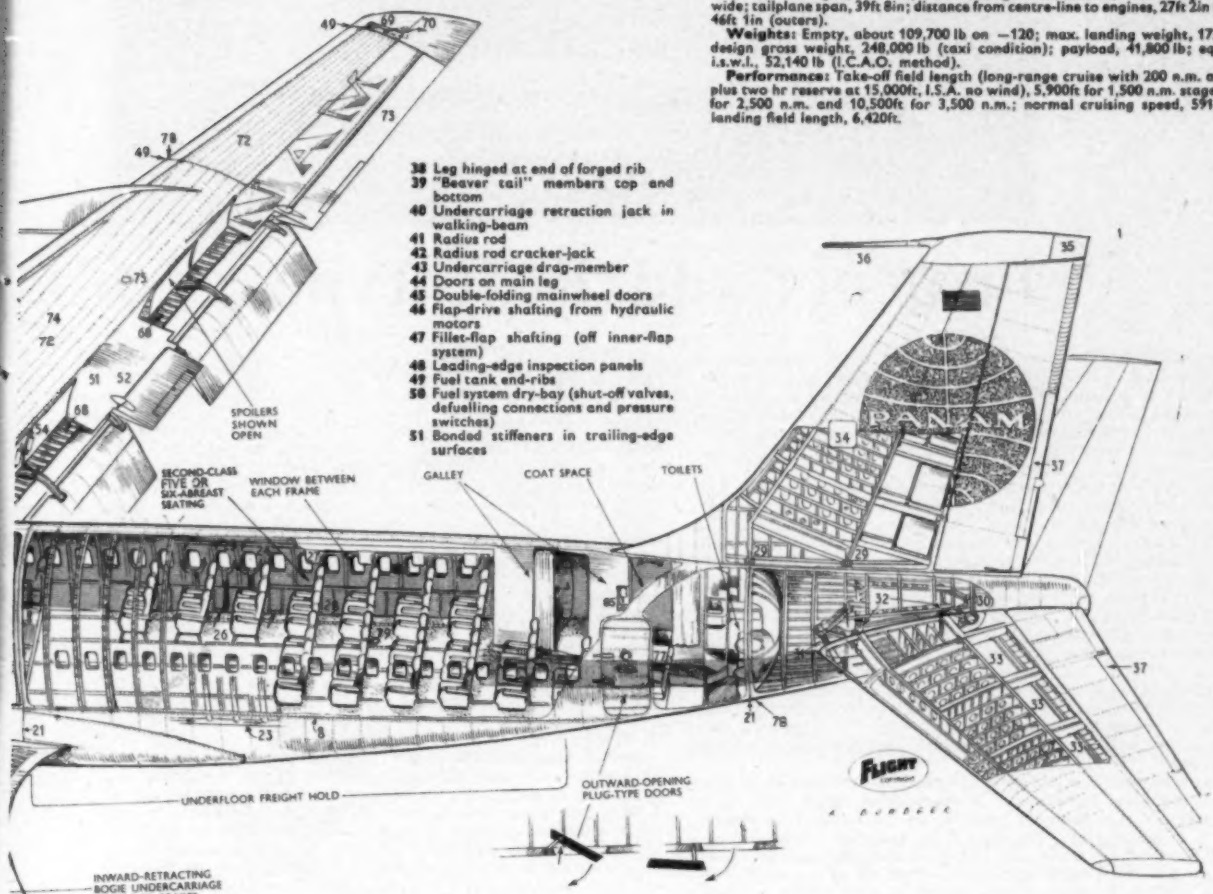
Payload Accommodation Standard seating for the -420 described above is 121 five-abreast at 40in seat pitch, but a wide variety of different arrangements is possible within the Boeing 707 range. Typically, with five-abreast seating, there is a 20in-wide aisle, and with six-abreast seating 18in. A possible two-class arrangement seats 42 first-class passengers five-abreast in the forward section and 83 passengers six-abreast in the aft section, with a ten-seat lounge in the forward compartment. Normal maximum seating is 130 in the short fuselage Stratoliner and Boeing 720, 150 in the 138ft long fuselage Intercontinental, but a 145ft 6in fuselage (40in is added both forward and aft of the wing) is also available. A total cargo volume of 1,500 cu ft is available in the -420 fuselage, 700 cu ft in the forward compartment, 800 cu ft aft.

These payload range curves cover the combinations of weights and powerplants of the series. Weights shown are at the start of the ground roll and allowances include take-off, climb to not more than 40,000ft, no descent credit, normal bleed power-extraction and suppressors.



25 Air delivery ducts under hat-racks
26 Air extraction at floor level
27 "Passenger service units"
28 "Hot-wall" panelling
29 Fin/fuselage joints
30 Pivot for variable-incidence tailplane
31 Tailplane screw-jack
32 Tailplane centre-section joints
33 Control-surface balance panels
34 V.O.R. aerial
35 Loran aerial
36 H.F. aerial
37 Control tabs

This Boeing 707 is a -120 Stratoliner with long fuselage. Seating is typical but not necessarily representative of the layout to be adopted in service by PanAm.



38 Leg hinged at end of forged rib
39 "Beaver tail" members top and bottom
40 Undercarriage retraction jack in walking-beam
41 Radius rod
42 Radius rod cracker-jack
43 Undercarriage drag-member
44 Doors on main leg
45 Double-folding mainwheel doors
46 Flap-drive shafting from hydraulic motors
47 Fillet-flap shafting (off inner-flap system)
48 Leading-edge inspection panels
49 Fuel tank end-ribs
50 Fuel system dry-bay (shut-off valves, defuelling connections and pressure switches)
51 Bonded stiffeners in trailing-edge surfaces
52 Honeycomb sandwich in trailing-edge surfaces
53 Hot-air de-icing, double skin full length of leading edge
54 Spoiler operating jacks
55 Flap screw-jack
56 Flap tracks and rollers
57 Gust damper (70 m.p.h. limit)
58 Aileron/spoiler linkage
59 Low-speed aileron linkage
60 Intake to cabin-air turbo-compressor (engines 2, 3 and 4)
61 Outlet from turbo-compressor
62 Airflow through engine oil-coolers
63 Oil tank
64 Main engine mounting
65 Rear engine "steady"
66 Aluminium cowlings
67 Firewalls
68 Cove-lip door (covers gap when flaps up)
69 Fuel system surge-tank
70 N.A.C.A.-type inlet to tank vent system
71 Electrical racks (forced air cooled)
72 Two (independent) boost pumps in each main tank
73 Honeycomb-sandwich aileron skins
74 Typical wing section
75 Gravity fuel fillers
76 Pressure-refuelling dry bay
77 Cabin attendants' seats
78 Production break-lines
79 Wide-angle lens for freight-hold inspection
80 Tank access doors
81 Spring tab (full surface movement available for ground test)
82 Sundstrand-driven 40kVA A.C. generators on engines 2, 3 and 4
83 Eight-seat lounge
84 Dividing screen (1st class forward, tourist aft)
85 Drinking fountain
86 Noise suppressors

BOEING 707-120

Four Pratt and Whitney JT3C-6 of 12,000 lb sea level static thrust each (dry)

Dimensions: Span, 130ft 10in; length overall, 134ft 6in ("short body"), or 144ft 6in ("long body"); height, 38ft 7in; gross wing area, 2,433 sq ft; track, 22ft 1in; wheelbase, 52ft 4in; max. fuselage cross-section, 170.5in high by 148in wide; tailplane span, 39ft 8in; distance from centre-line to engines, 27ft 2in (inners), 46ft 1in (outers).

Weights: Empty, about 109,700 lb on —120; max. landing weight, 175,000 lb; design gross weight, 248,000 lb (taxi condition); payload, 41,800 lb; equivalent i.s.w.l., 52,140 lb (I.C.A.O. method).

Performance: Take-off field length (long-range cruise with 200 n.m. alternate plus two hr reserve at 15,000ft, I.S.A. no wind), 5,900ft for 1,500 n.m. stage, 7,780ft for 2,500 n.m. and 10,500ft for 3,500 n.m.; normal cruising speed, 591 m.p.h.; landing field length, 6,420ft.

BOEING 707-220

Four Pratt and Whitney JT4A-3 of 15,500 lb sea level static thrust each (dry)

Dimensions: Span, 130ft 10in; length overall, 134ft 6in; height, 38ft 3in; gross wing area, 2,433 sq ft; track 22ft 1in; wheelbase, 52ft 4in; max. fuselage cross-section, 170.5in high by 148in wide; tailplane span, 39ft 8in; distance from centre-line to engines, 27ft 2in (inners), 46ft 1in (outers).

Weights: Empty, 111,700 lb; max. landing weight, 175,000 lb; max. gross weight, 248,000 lb; payload, 33,800 lb.

Performance: Field lengths, shorter than -120; normal maximum cruising speed, 608 m.p.h.

BOEING 707-320

Four Pratt and Whitney JT4A-3 of 15,500 lb sea level static thrust each (dry)

Dimensions: Span, 142ft 5in; overall length, 144ft 6in; height, 38ft 8in; gross wing area, 2,892 sq ft; track, 22ft 1in; wheelbase, 55ft 8in; tailplane span, 45ft 8in; distance from centre line to engines, 33ft (inners), 51ft 11¼in (outers).

Weights: Empty, "over 120,000 lb"; max. landing, 195,000 lb; zero fuel weight, 177,500 lb; max. take-off weight, 295,000 lb (296,000 lb for taxying); payload, 38,000 lb.

Performance: Take-off field length (assumptions as for 707-120), 5,550ft for 1,720 st. m. stage, 6,850 for 2,900 st. m. and 8,550ft for 4,000 st. m.; normal cruising speed, 600 m.p.h.; landing field length, 6,400ft.

BOEING 707-420

Four Rolls-Royce Conway 505 of 16,500 lb sea level static thrust each

Dimensions: As for 707-320.

Weights: Manufacturer's empty weight, 121,468 lb; operating empty weight, 128,314 lb; max. landing weight, 195,000 lb; zero fuel weight, 177,500 lb; max. take-off weight, 295,000 lb (296,000 lb for taxying); payload, 38,000 lb.

Performance: Take-off field length, max. T.O. weight, 9,000ft; cruising speed at 200,000 lb at 30,000ft, 585 m.p.h.; landing field length at 190,000 lb, 6,280ft.

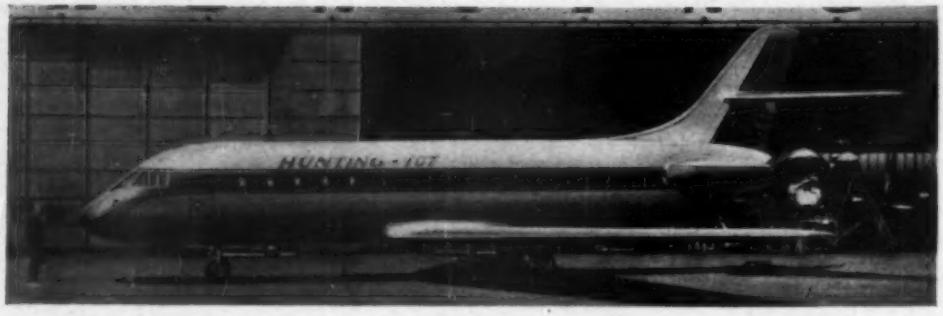
BOEING 720

Four Pratt andWhitney JT3C-7 of 12,000 lb sea level static thrust each (dry)

Dimensions: Span, 130ft 10in; length overall, 136ft 2in; height, 38ft 4in; gross wing area, 2,433 sq ft; track, 21ft 11in; wheelbase, 50ft 8in; max. fuselage cross section, 170.5in high by 148in wide; tailplane span, 39ft 8in; distance from centre-line to engines, 27ft 2in (inners), 46ft 1in (outers).

Weights: Maximum take-off weight, 203,000 lb; max. taxi weight, 203,000 lb; maximum landing weight, 165,000 lb; normal landing weight, 142,000 lb; zero fuel weight, 136,550 lb; operating weight empty, 104,007 lb; payload, 32,543 lb.

Performance: Cruising speed, (over 600 m.p.h.); normal cruise altitude range, 15,000 to 40,000ft; range with full payload and reserves, up to 3,300 st.m.



An artist's impression of the Hunting H-107

Projects and Prototypes

Agusta AZ.8 To some extent this machine is intended to fill the elusive DC-3 replacement function, although, unlike its competitors, it is no larger in capacity than the DC-3. It adheres to the formula of four piston engines, an unpressurized fuselage, outstanding field performance and extremely simple systems. Agusta are promoting the AZ.8 for a variety of civil and military rôles where speed is not a prime requirement.

The wing comprises a 43ft 4in centre section and 20ft 2in outer panels. Surprisingly, only one spar is used, plus a rear false spar to complete the box and carry the ailerons and slotted flaps. A total of 4,700 lb of fuel is housed in flexible cells inboard of the inner nacelles. The oval-section fuselage has a cross-section 5ft 11in wide and 8ft 2in high, giving a usable interior 65in wide and 75in high in the aisle. This width is sufficient for a row of single seats down either side, and configurations have been evolved seating up to 26 passengers. In all cases there is a large rear baggage compartment and a smaller hold at the front, as well as a forward toilet. The forward-retracting landing gear employs five identical tyres (either of 22in or 29in size, according to airfield surface) and incorporates hydraulic steering and braking. Power is provided by four Alvis Leonides 502/5 engines, each rated at 540 h.p., driving de Havilland constant-speed, feathering propellers.

The prototype flew for the first time on June 9 and its progress has so far been satisfactory. A considerable proportion of the development cost has been paid for by the Italian Government, and it is possible that Agusta will be awarded a contract for a small batch for the Italian Air Force, to enable a line to be started.

Span, 83ft 8in; length, 63ft 9in; wing area, 719 sq ft; available cabin volume, 980 cu ft; empty weight, 15,650 lb; gross weight, 23,800 lb; overload weight, 24,900 lb; sea-level take-off (I.S.A.) with all engines, 1,345ft run, 1,770ft to 50ft; rate of climb at 23,800 lb at sea level, 1,110ft/min; service ceiling, 25,900ft; cruising speed at sea level, 212 m.p.h.; cruising speed at optimum height of 9,850ft, 230 m.p.h.; payload/range performance (22 seats): 6,200 lb to 620 st. miles, thereafter falling to 4,350 lb at 1,000 miles (V.F.R.).

Blackburn B.107 Although conceived primarily to meet the requirements of the British armed forces, the B.107 has obvious commercial possibilities and is being actively marketed in that field. The wing is essentially that of the Beverley, although it has been restressed to contain more fuel and accept the greatly increased thrust of four Rolls-Royce Tyne turboprops, each of some 5,500 e.h.p. Beneath the wing is suspended a large fuselage with a pressurized interior capable of accommodating car-sized vehicles two-abreast. Access to the interior would be gained through nose doors and a rear ramp, and numerous configurations have been investigated with a potential seating capacity of approximately 200 (although in commercial use about 150 would rarely be exceeded). Owing to its relatively low wing- and power-loading, the B.107 should have excellent field performance and its multi-wheel undercarriage is designed for operation from unprepared strips. A first cost of £840,000 has been unofficially reported.

Span, 162ft; length, over 100ft; wing area, approximately 3,000 sq ft; gross weight, 167,500 lb; capacity payload, 53,000 lb; range/payload performance, 2,500 nautical miles carrying a payload of 38,500 lb at 325 kt.

Bréguet 941 Now under active development, the 941 STOL transport is a scaled-up derivative of the 940 Intégral research machine, a detailed three-view of which was published in last week's issue. Powered by four turboprops in the 1,000 s.h.p. class—Turboméca Turmo IIIs initially, or T58s should the latter be available earlier—the 941 is intended for various civil and military rôles. The rectangular interior will be 30ft 9in long, have a cross-section 98in wide by 102½in high and seat up to 50 passengers.

Span, 77ft 5in; length, 79ft 4in; wing area, 898 sq ft; empty weight, about 14,000 lb; gross weight, 32,500 lb; recommended cruising speed, about 220 kt; calculated field-length (I.S.A., sea level), 990ft; take-off to 50ft, 649ft; payload/range, up to 370 miles with full payload of 12,100 lb.

Bristol 200 Earlier this year the Bristol 200 project came prominently into the news as a major contender for the B.E.A. short-haul jet contract. So attractive was the design that the Hawker Siddeley Group discarded their own project and joined forces with Bristol in an attempt to market (and, had they been successful, to manufacture) the Bristol 200 as a co-operative venture.

A description, and detailed external drawings, of the 200 appeared in our issue of January 24 of this year. With a configuration similar in essentials to that of the D.H.121 (page 120) the 200 could be powered by three Curtiss-Wright Zephyrs, Bristol Olympus 553s, Rolls-Royce Avon RA.29s or R.B. 141s. The specification below is representative of the project as it was six months ago.

Span, 91ft; length, 121ft 6in; number of passengers, 79 to 99; gross weight, 120,000 lb; cruising speed, 610 m.p.h. at 25,000ft; range/payload performance, 2,880 st. miles in still air with capacity payload of 21,000 lb or 3,600 miles with full tanks and 13,000 lb payload.

British Supersonic Transport In addition to private projects by several individual manufacturers, the overall feasibility and economics of supersonic air transport are being investigated by a joint committee formed from the R.A.E., manufacturers and other interested parties. This committee has been in existence almost a year. On November 18, 1957, the Parliamentary Secretary to the Ministry of Supply stated "much preliminary theoretical work has been done, the main experimental work has been planned and certain research models are now being designed and manufactured." The most recent reference to the committee's work was given by the Minister of Supply himself on July 14, when he said "a study is being made of the feasibility of an economic civil transport. Broadly, it is the opinion that there could be an economic civil transport. What is in issue is the kind of transport that would, in fact, be the most economic. . . ."

CASA 209 and H.F.B. 209 Both these machines are turboprop derivatives of the CASA 207 Azor, a twin-Hercules transport by the national Spanish constructor. Known as the Super Azor, the CASA 209 is still an active project, and the specified powerplants are two Napier Elands, with Allison 501s as optional alternatives. The H.F.B. 209 was to have been a licence-built version by Hamburger Flugzeugbau, but there are indications that the German company have transferred their aeronautical activities to other projects.

de Havilland D.H.C.4 Caribou Although the first batch of Caribous are for a military customer—the U.S. Army—the design combines such unusual attractions as to be of great interest to many commercial operators using small and unprepared fields. Although the payload/range figures are inferior to those of a DC-3, notwithstanding the slightly greater power, this is largely offset by the outstanding field performance, which is better than that of any other fixed-wing aeroplane of such a size yet built.

Mounted high on the fuselage, the wing is provided with double-slotted flaps over the entire span, and by clever engineering the rear parts of the outermost portions of the flaps also serve as ailerons. The leading edge ahead of the ailerons is arranged to droop at low speeds so as to improve behaviour at very high angles of attack. Flying controls are fully manual and relatively conventional, although the tail volume is exceedingly great, to confer good control at speeds as low as 60 kt. Power is provided by a pair of Pratt and Whitney R-2000 engines, each rated at 1,450 h.p., driving special Hamilton Standard propellers with a diameter of 13ft 1in and three blades of high solidity.

The unpressurized fuselage has a hold measuring 25ft from the

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THE WIDGEON AT THE BRUSSELS FAIR

Operated by Sabena, the Widgeon helicopter has to date carried nearly 2,000 visitors on scheduled services between the Exhibition heliport and destinations beyond, and has given 100% serviceability during this period.

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Triple "Traveller" showing three variations of headpiece.

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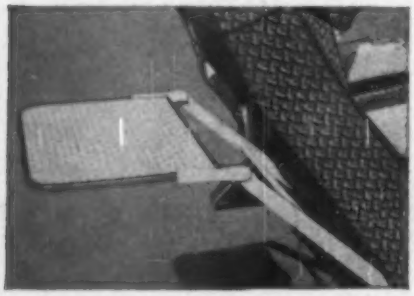
Tip-up seats make passenger access easier and simplify cleaning.

Tray tables remain in horizontal position and at constant height.



'Traveller' Seating

in Britannia and Comet IV aircraft for B·O·A·C

★ Tip-up seat for ease of access and cleaning

★ Tray tables remain at constant height

★ Folding leg to facilitate stowage when freighting

★ Interchangeable backs, arms, seat pans and legs

★ Single beam, unit construction

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MA2

Projects and Prototypes . . .

bulkhead behind the flight deck to the lip of the full-section loading ramp/door at the rear; cross section dimensions are 87in wide and 75in high under the wing. Typical seating configurations are nine rows of three seats (27 passengers) or four rows (12 passengers) and 650 cu ft of freight.

First flight of the second prototype (the first to fly) is scheduled for late August or early September, and deliveries to the U.S. Army are to begin early next year. Plans are in hand for a number of developments, one of the logical steps being to fit turboprop engines such as the Dart or T55.

Span, 96ft; length, 68ft 10in; wing area, 912 sq ft; empty weight, 16,355 lb with fixed equipment; gross weight (also zero-fuel and landing limits), 24,000 lb; I.S.A. sea-level take-off, both engines, 490ft run or 840ft to 50ft; balanced field length, operating to airline technique, 2,070ft; cruising performance, 177 m.p.h. at 7,500ft at full load; range with max. payload (6,800 lb passenger or 7,600 lb as freighter), 1,000 st.m. without reserves.

Douglas DC-9 This designation identifies a family of projects for a jet transport resembling, but smaller than, the DC-8. Suggested powerplants have included four Pratt and Whitney JT3s or JT8s, two Pratt and Whitney JT4s, two Rolls-Royce Conways, four Rolls-Royce Avons or R.B. 141s or four G.E. CJ-805s. Douglas have always believed that the formula is logical (gross weight has hovered in the neighbourhood of 120,000 lb) and are still testing airline reactions. A full specification for the original Model 1925 was published in *Flight* of July 6, 1956.

Douglas Supersonic Projects As expected, the Douglas Aircraft company have been reticent about their plans for the next "speed plateau" to follow the DC-8. According to the American journal *Aviation Week* the company are examining the possibility of producing a Mach 2 airliner; our contemporary states "it seems reasonable to expect Douglas to be ready to fly it in about two years."

East German Type 152 Also known as the BB-152 (for Prof. Bruno Baade, leader of its design team at the Dresden Aeronautical Institute), this aeroplane is the first transport design project completed in East Germany since 1945. Its ancestry can be traced to Junkers bomber projects of World War 2, but it nevertheless remains quite a competitive product which may see service with the East German national airline. Already the airfield at Schönfeld, East Berlin, is being greatly extended to match the requirements of the 152 and Soviet jet transports.

The 152 is very much a middle-of-the-road design, having accommodation for from 48 to 72 passengers, a cruising speed of about 500 m.p.h. and a "theoretical range" (presumably without reserves) of from 1,000 to 2,000 miles. Design features include a constant-taper wing swept at 35 deg and mounted high on the fuselage. The latter has an oval section and is pressurized to a differential of 8 lb/sq in. Power is provided by four East German/Soviet Type 014 turbojets mounted in twin underwing pods; each engine has a rated thrust of 6,970/7,050 lb and is at present unsilenced. Conventional control surfaces are used, and their inset hinges and large tabs suggest that they are not fully powered. The prototype 152 has a bicycle undercarriage, but the production version reverts to a more conventional arrangement, with a four-wheel bogie beneath each engine nacelle.

Several interior schemes have been investigated. The most probable arrangement has a mixture of four- and five-abreast seating for 72 passengers, but other interiors equipped for 57 or 48 passengers have also been proposed. The fuselage cross-section is decidedly small for real flexibility, and baggage and freight—carried under the floor and at the ends of the cabin—is relatively restricted. The first prototype, which in addition to the curious undercarriage also has a transparent nose, was wheeled out of the Dresden Plant 2 on May 1. Owing to minor difficulties it has not yet flown but is now expected to take the air in mid-August. Taxying tests are reported to have been in progress since June 20. It is at present planned that a small production series shall be undertaken next year.

Span, 86ft 3in; length, 103ft; wing area, 1,479 sq ft; empty weight, 62,000 to 63,500 lb; gross weight, from 88,185 to 99,208 lb; breakdown for 57-seat version, 62,800 lb basic, 12,530 lb payload, 21,869 lb fuel, giving take-off weight of 97,199 lb; payload/range performance as 57-seater, range without reserves, 1,243 st.m. cruising at 497 m.p.h.; take-off ground run (no qualifications stated), 3,230ft; distance to 10.7m (34ft), 4,315ft; "landing speed," 124 m.p.h.

Type 153 Generally similar to the Type 152 in external appearance, the 153 is fractionally larger and has more powerful engines. No firm details have been reported, but it is claimed that the 153 will provide mixed-class seating for 90 passengers. The 153 is expected to follow the 152 into production in 1960.

Frye Projects Since 1955 the American Frye Corp. have been promoting a series of high-wing propeller-driven transports intended for outback routes where field-length and ease of servicing dominate over speed. These projects have been fully reported in our pages, including our 1956 and 1957 airliner review issues. Frye have yet to succeed in concluding satisfactory financial arrangements, or to find a company to manufacture one of the designs in quantity.

Handley Page Victor Developments Since 1951 Handley Page have been investigating the practicability of producing transport versions of the H.P.80 Victor bomber. These projects are now naturally centred upon the characteristics of the Victor B.Mk 2 which is powered by four Rolls-Royce Conway by-pass turbojets, each of 17,250 lb thrust. The Civil Victor proposed to B.O.A.C. was described in our issue of May 24, 1957, and would have had a gross weight of 214,000 lb, but the H.P.111 heavy military transport—suitable for both passenger and freight operations—has a projected weight of 225,000 lb. Its capacity payload is 53,000 lb, and this is carried 3,250 nautical miles cruising at 470 kt.

Hunting H-107 The following statement has been issued by Hunting Aircraft, Ltd., outlining their thoughts for this attractive design:—

"The Hunting H-107 is designed as a twin turbojet short-range transport to carry up to 48 passengers at a cruising speed of 400 knots on stage lengths of around 700 nautical miles. Still-air range is 1,350 nautical miles.

"The history of the H-107 began two years ago when it was decided to design a turbojet transport suitable for short-haul routes. Studies of likely routes all over the world had confirmed that there were many on which the higher frequencies offered by a turbojet transport would show economic advantages.

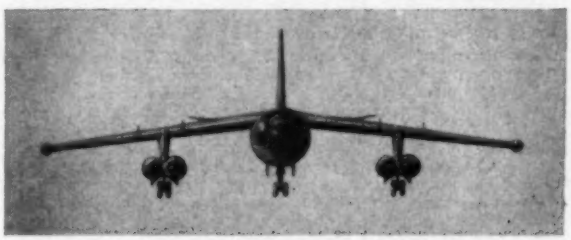
"Discussions with operators in a representative selection of countries modified the original basic specification to provide a 700-800 n.m. stage length, an all-up weight of 41,500 lb and a balanced field-length of 5,000ft.

"Twin Bristol Orpheus 810 engines, each rated at 5,200 lb, are situated at the extreme aft end of the fuselage behind the rear fuselage pressure bulkhead, thus keeping the pressure cabin outside the cones of noise and jet efflux. Silencers or thrust reversers can be fitted if required; water injection would be used for power-restoration.

"This new project has reached the final design study stage and initial wind-tunnel tests confirm most satisfactorily the aerodynamic estimates."

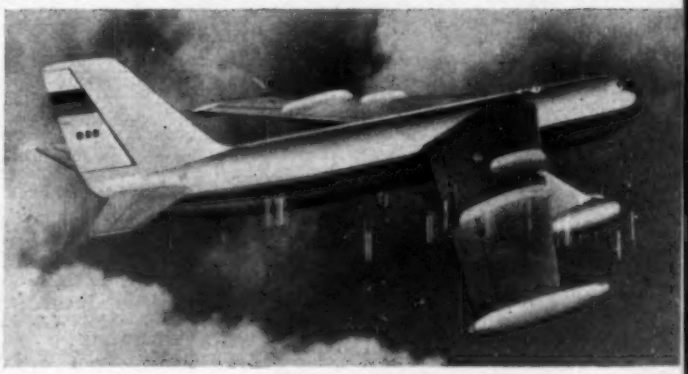
Span, 80ft; length, 77ft 9in; wing area, 800 sq ft; sweepback of wing, 20 deg at quarter-chord; internal cabin dimension, excluding flight deck, total volume 1,000 cu ft, usable floor 360 sq ft, length 19ft, height, 74½in, width 102in; seating capacity, 40 with 388 cu ft baggage (225 cu ft of baggage above floor), 44 with 353 cu ft or 48 with 313 cu ft; weight breakdown, basic operating 20,670 lb, fuel 17,480, payload 10,960, gross 41,500 (zero-fuel 31,630 and landing 39,500); balanced field-length, 4,800ft at I.S.A. sea level; recommended cruise at 34,500 lb, 400 kt (461 m.p.h.) with consumption of 455 Imp. gal/hr; range/payload, 950 n.m. with full payload or 2,000 n.m. with 3,600 lb payload.

Japanese Project In our issue of May 23 we gave a relatively complete specification and report on a twin-turboprop airliner

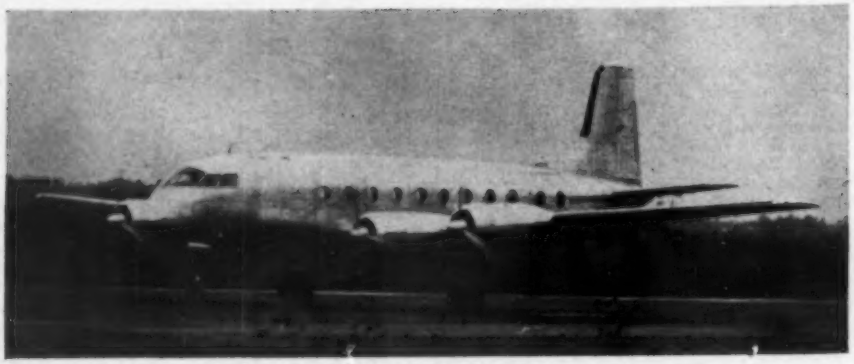


Frontal aspect of the production Type 152.

Below, model photograph of the Type 152.



Projects and Prototypes . . .



The prototype Agusta AZ.8.

which is a joint project by Mitsubishi, Kawasaki, Showa, Fuji and two other firms—in fact, virtually the whole Japanese industry. The project is quite conventional in appearance, although two versions, with very different engine power, are projected.

First to be built would be a machine powered by two Rolls-Royce Dart 540-series engines. This would weigh 43,000 lb, seat up to 60 and cruise at about 320 m.p.h. over stages up to 500 st.m. with full load, or 1,000 st.m. with 50 passengers. It has been stated that a prototype of this variant would fly early in 1960. The fuselage would be pressurized. The wing, of only 14 per cent thickness at the root and 12 per cent at the tip, would carry double-slotted flaps over almost the entire span, the small ailerons being supplemented by spoilers of high aspect ratio.

A later development, with characteristics outlined below, would have two Rolls-Royce Tyne engines, and would seat up to 70 passengers in a slightly lengthened fuselage. Like the Dart version, the more powerful model would be designed to provide high performance from indifferent airfields.

Span, 92ft 9½in; length, 86ft 11in; wing area, 861 sq ft; empty weight, about 31,000 lb; gross weight, 55,500 lb; I.C.A.O. field length, 3,940ft; recommended cruising speed, 415 to 430 m.p.h.; range with 70 passengers, 600 st.m.; range with 60 passengers, 1,000 st.m.

Lockheed Model 282A As the commercial variant of the C-130B Hercules of the U.S. Air Force, the 282 can be regarded as a fully developed and proven vehicle. Powered by four 4,050 e.h.p. Allison 501-D15 or -D22 turboprops, driving four-blade propellers generally similar to those of the Electra, the 282 has a 4,300 cu ft interior, pressurized to 7½ lb/sq in and capable of seating up to 95 or of accommodating over 35,000 lb of cargo.

Span, 132ft 7in; length, 97ft 9in; wing area, 1,745 sq ft; empty weight, 58,700 lb; gross weight, 135,000 lb (increased weights are being investigated); payload/range, about 3,100 n.m. with 25,000 lb payload cruising at 320 kt (capacity payload is 38,800 lb).

Lockheed Supersonic Project It is known that the Lockheed Aircraft Corp. have been investigating the economics of supersonic transport aircraft for at least five years. In April of this year Mr. C. L. "Kelly" Johnson said "there is no sense in being a little bit supersonic; let's go." He suggested a "long and sharp" vehicle weighing 450,000 lb, cruising at Mach 3 at 80,000ft and having a range (unqualified) of 3,500 miles. Shortly thereafter Mr. Hall L. Hibbard emphasized that, owing to its "enormous power and . . . surprisingly large wing," the Lockheed project would have excellent airfield performance. Work on construction of a prototype could begin in 1959 and the first flight could take place in 1962.

Morane Saulnier M.S.880 Under this designation the renowned French company have planned a transport, of unusual configuration, powered by four Turboméca Gabizo turbojets, each rated at 2,425 lb thrust. The pressurized fuselage could be equipped for a variety of rôles and up to 40 seats could be accommodated. The project is still very much in the paper stage.

North American Supersonic Project All other factors being equal, it is a fair assumption that the company which first produces a long-range highly supersonic bomber will also be the first to produce a supersonic airliner. North American Aviation, Inc., are developing the B-70 Valkyrie bomber under a U.S. Air Force contract, and the company's chairman, Mr. J. H. Kindelberger, has pointed out how suitable this design is as a jumping-off point for a supersonic transport.

Powered by six General Electric X-279 (J93) turbojets, burning kerosine in the main combustion system and alkylated-borane fuel in the afterburners, the B-70 has a cruising speed of at least Mach 3 (3.25 has been suggested) and a range, without air-refuelling, of well over 6,000 miles. Payload is certain to be at least 30,000 lb. Although the ton-mile cost is likely to be appreciably greater than that of the subsonic "big jets" this performance has yet to be matched by any other project for a supersonic transport.

Republic Rainbow Since the end of 1957 the Republic Aviation Corp. have been testing airline reaction to their proposal for a four-turboprop transport falling midway between the Viscount and Electra in size and ability, and having particularly outstanding field-length. Power would be provided by four 2,600 h.p. engines—Rolls-Royce Dart RDa.10s or General Electric T64s have been suggested—and the wing would have large, slotted Fowler flaps and leading-edge slats. Seating would be provided for from 68 (five-abreast) to 80 (with some rows having six seats). The following specification refers to the Dart-engined version, which would be slightly heavier than the T64 machine.

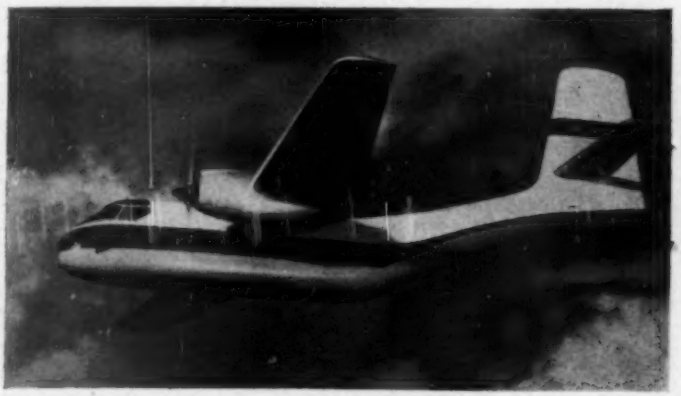
Span, 111ft 11in; length, 87ft; wing area, 1,150 sq ft; empty weight, 42,500 lb; gross weight, 77,500 lb; take-off field-length, 3,160ft; landing requirement, 4,000ft; cruising speed, 408 m.p.h.; maximum payload, 19,200 lb, with 15,420 lb of fuel for a 1,500-mile stage; maximum-fuel payload, 17,620 lb, suitable for a stage of some 1,700 miles.

Saben-Hart Flying Boat Last November the London engineering firm of Saben, Hart and Partners announced plans for a very large flying boat. It was to have an airframe incorporating much Calottan dimpled light alloy, and power was to be provided by eight 25,000 s.h.p. turboprops of unspecified type. The gross weight of a passenger version was to be 1,250,000 lb, the maximum seating capacity 606 and the cruising speed 660 m.p.h. A freight version was to weigh 3,000,000 lb and cruise at 500 m.p.h.

Short/Bristol P.D.18 Britannic In its essentials, the Britannic has a Britannia wing mounted high on a completely new fuselage giving an internal pressurized volume roughly 50 per cent greater than that of a Britannia 310. The Britannic is being planned in four stages, any or all of which are being marketed in both military and commercial fields. All have basically the same fuselage, with a cabin measuring 80ft by 12ft diameter, capable of seating well over 150 passengers and provided with a large rear ramp and forward doors to admit bulky cargo or vehicles. The Britannic 1 would have four Proteus 255s, and characteristics similar to those outlined in the specification below. The Britannic 2 would have Proteus engines of increased power, a slightly increased payload and generally improved performance. The Britannic 3 would have four Rolls-Royce Tyne engines and still further improved performance, and the Britannic 4 would have late-model Tynes and a new wing, permitting a cruising speed of about 390 kt and a maximum payload of at least 95,000 lb.

Span, 142ft 3½in; length, well over 100ft; wing area, approximately 2,075 sq ft; gross weight, 183,500 lb; capacity payload, 60,000 lb; payload/range, 2,500 nautical miles carrying 36,000 lb payload and cruising at 300 kt.

Artist's impression of the de Havilland D.H.C.4 Caribou.



Straight and Level

THE other day a *Flight* colleague peered into one of the two underbelly freight holds of the first Vickers Vanguard—now looking quite like an aeroplane on the Weybridge production line. He counted 14 men at work inside; and not one appeared to be getting in any other's way. It is only when you have seen things like this with your own eyes that you truly realize what they mean—in this case the something-for-nothing which the Vanguard offers.

Strictly speaking, the Vanguard's big freight capacity is not entirely something for nothing. If Vickers had gone for smaller freight holds they could probably have produced a design offering more passenger payload (five passengers and their baggage perhaps) and less drag (five cruising m.p.h. or so). But this seems to me a small price to pay for the ability to top-up with freight—real bulky stuff from truck-bed height—when passenger traffic is thin. And is there any airline which does not have off-peak passenger traffic problems?

● Like Rod Banks of Bristol, I feel that Sweden's procurement of military aeroplanes has been quite outstandingly good. It is instructive—and to some nations an object-lesson in what might have been done had money been better spent—to stack up the Saab-29 against its contemporaries in other countries, or to compare the Saab-32 with equivalent machines available elsewhere.

As for the Saab-35, I feel that every non-Swedish chief designer or air officer should be required to study it and explain why no other non-Soviet nation has such a fine all-weather intercepter in such an advanced state of development. If I were an air force general or air marshal I would give a very great deal to know what the Royal Swedish Air Board are up to now. Their next weapon will be well worth watching, because it will probably be the right one for the job.

● A famous peer, as reported by Hansard, following last week's Lords debate on the aircraft industry: "My last question deals with Transport Command. It has now approximately 100 four-engined aircraft. Those are Blackbirds, Beverleys, Comet 2s and Hastings."

● I am taken to task by Handley Page for my comments on Sir Arthur Harvey's statement in Parliament about the lack of Government support for the Herald. Sir Arthur stated that Fokker had had "orders" for the Friendship from the Dutch Government.

As I remarked, the Dutch Government's order for one Friendship hardly ranks as Government support. But it seems that Sir Arthur did have a point; he just didn't make it correctly. Fokkers *have* had considerable Government backing—to the extent of £2½ million (27m guilders). This money, which presumably covered a major part of the Friendship's design, development and tooling costs, was lent to Fokker—interest-free—by the Netherlands Board for Aircraft Development (N.I.V.), a Government concern. The loan was made in the Friendship's early design stages, and it will be repaid in the customary way as a levy on production deliveries.

I have had these facts checked with Fokker, who say that they do not think the Friendship could have succeeded without official support. According to a recent report in the *Yorkshire Post*, which Handley Page do not deny, the firm stands to lose £4 million if it cannot sell the 25 aircraft which, orders regardless, it is determined to produce.

● Some U.S. Army men found a wild burro (donkey to you) in an old corral near Red Canyon. They took him back to their nearby camp, which is a Nike missile practice-firing unit, and appointed him as official mascot of the Red Canyon Rocket Camp.

This helps to explain my picture—except for the English gentleman, who is disguised as Steve Barber of the *News Chronicle*.

● I was rather surprised to read in the *Financial Times* the following assertion: "Outside financial interests are discouraged from investing in independent airlines, and there is insufficient money with which to buy expensive modern aeroplanes."

I think there is plenty of capital behind the shipping firms which back our leading independents. They are just hesitant to spend it until the Conservative Government's "new deal" of 1952, which encouraged the shipping investment in the independents, comes to something.

● Airline traffic statistics are pretty dry stuff. But the fact that they mean something to only a few is no excuse for inaccuracy when the correct figures are easily available.

In the May issue of Air-India's house journal *Magic Carpet* I read that "last year 90 million people travelled by air on scheduled flights throughout the world." A few weeks later I picked up the June issue of *B.O.A.C. Review* to learn that "the grand total carried last year by all airlines was about 80 million people."

By no stretch of imagination could the expression "last year" mean anything else but 1957: and I.C.A.O.'s 1957 traffic statistics show that scheduled services in that year carried 87 million passengers.

No wonder there's so much confusion about airline traffic growth when the raw material itself gets misquoted.

● I was reminded of a comment of mine (April 4) on reading the proceedings of an international scientific meeting at The Hague. It was there agreed that, before anybody starts planting vehicles or nuclear devices upon the face of the moon, we had all better sit down and think again . . . and then think again. It is vital, the scientists concluded, to safeguard any life on other heavenly bodies, and to avoid creating cosmic disturbances. I'm glad to see that Earth is now unlikely to start behaving like a spoilt child with a powerful new toy.

● Can anybody tell me where I can find A. V. Roe and Co.? Their address is Greengate, Middleton; but I always think of them as being at Manchester. The factory itself is at Chadderton (the nearest city being Oldham), and the telephone exchange is at Failsworth . . . what's more, the floor is gradually subsiding, owing to ancient subterranean workings, and this messes up the jigging. Yet somehow they seem to have turned out more pounds of airframe than any other plant in Europe.

● Extract from Hansard, July 14:

MR. J. B. EDEN [Con., Bournemouth W.]: Can my right hon. Friend [The Minister of Supply] give any indication now as to the plans for the development of the supersonic transport aircraft? Can he also say what amount of money will be spent on research and development in the industry, and, if it is possible, will he also confirm that it is his belief that the production of manned aircraft for military purposes must continue and that where men employed on those manned aircraft are rendered redundant as a result of the cut in the amount of production that takes place, he will, so far as possible, ensure that they will be found alternative employment?

MR. SPEAKER: Order. That is quite enough.

Carry on, Mr. Eden. We are all interested.

ROGER BACON

Air Marshal Sir Frederick Scherger, Chief of Staff of the R.A.A.F. (far left picture), admires the Malayan kris presented to No. 1 Sqn., R.A.A.F., before it left Singapore, being shown to him by the C.O., W/C. K. Robertson; and in the right-hand picture W/C. C. W. Steley, C.O. of No. 2 Sqn. (left centre), which has recently gone to Malaya, shows Mr. R. G. Menzies, Prime Minister of Australia, the R.A.A.F. bombing trophy won by the squadron. With them are G/C. C. F. Read, O.C. No. 82 Wing, and G/C. D. R. Chapman, who is station commander at R.A.A.F. Amberley.

SERVICE AVIATION

Royal Air Force and Naval Flying News

Personnel Appointment

A.O.C. the R.A.F. Flying College, Manby, since March 1956, A. Cdre. P. H. Dunn has recently taken up the appointment of Director of Personnel (Air) at Air Ministry.

He was awarded the D.F.C. in February 1941 after commanding first No. 80 and then No. 274 Sqn. during a period in the Western Desert when they shot down 92 enemy aircraft. He was appointed C.B.E. in August 1950 for services in Malaya (where he had since May 1949 been S.A.S.O. at A.H.Q.) and in 1956 he was appointed C.B. From July 1953 until January this year he was an aide-de-camp to the Queen.

Berlin Cup Winners

FOR the second year running the Berlin Air Lift Gold Cup (presented in 1955 by an anonymous donor to commemorate the part played by the R.A.F. in the 1948-49 airlift) has been won by No. 24 (Commonwealth) Sqn. of Transport Command, which flies Hastings and is commanded by S/L. D. W. Hitchins, R.A.A.F. The cup, which is of solid gold, goes annually to a Transport Command squadron which took part in the airlift, and it is awarded for general efficiency, flying safety, courtesy and aircrew smartness. At a ceremony at R.A.F. Colerne recently it was presented to the squadron by Air Marshal Sir Andrew McKee, A.O.C-in-C. Transport Command.

Escaping Award

NOW adjutant of the Flying Wing H.Q. at R.A.F. Wildenrath in 2nd T.A.F., after flying as a navigator there with No. 88 Sqn. since 1956, F/L. Keith Henderson has been chosen as the first winner of the R.A.F. Escaping Society Trophy presented by Col. J. D. Sherwood. This is awarded annually for the best individual feat of combat survival carried out by a member of the R.A.F. during operations or training.

In April last year F/L. Henderson took part in an escape and evasion exercise organized by the U.S.A.F. in Germany. He was captured by the "enemy" forces, who removed his boots, food and protective clothing. While being taken to "prison," F/L. Henderson undid his bonds and then escaped, making a trek of 25 miles back to base without footgear and food over rocky terrain in cold and wet weather. H.Q., 2nd T.A.F., in recommending him for the award said that his outstanding determination and will to succeed was in the best tradition of the R.A.F. and emulated the spirit inspiring the great wartime escapes.

The trophy will be presented to F/L. Henderson by Air Chief Marshal Sir Ronald Ivelaw-Chapman, chairman of the R.A.F. Escaping Society, at Air Ministry on July 29.

Marshal of the R.A.F. Sir William Dickson, who (as recorded on our news pages) has been appointed to the newly established post of Chief of the Defence Staff.

A.V-M. V. S. Bowling, A.O.C. No. 11 Group, receives from W/C. E. J. ("Billy") Wicht, C.O. of No. 152 Sqn., the squadron badge at a ceremony at R.A.F. Stradishall when the squadron was disbanded; and (far right) F/Sgt. John Lees shows his wife the George Medal he received from the Duke of Edinburgh (deputizing for the Queen) for his heroic rescue of an Army officer last January when leading the R.A.F. Valley mountain rescue team.

R.A.A.F. London Post

AMONG R.A.A.F. appointments recently announced is that of G/C. A. D. Henderson as S.A.S.O. at R.A.A.F. Overseas H.Q. in London. He succeeds G/C. I. J. Roberts, who is to be Director-General Personnel at the Department of Air, Melbourne.

Fitness Inspector Retires

WHEN the R.A.F. Physical Fitness Branch held its annual reunion dinner in London recently the occasion was also an official farewell to G/C. J. C. Kilkenny, the R.A.F. Inspector of Physical Fitness, who is retiring in September after 16 years' service in physical fitness and parachute training work. He will be succeeded by W/C. J. R. W. Blyth (with the acting rank of group captain), who has commanded No. 1 Parachute Training School at R.A.F. Abingdon since June 1953.

G/C. Kilkenny, who is 50, won England amateur association football caps in 1937 and 1938. He joined the R.A.F. in 1939 and in 1941 was appointed chief ground instructor (subsequently becoming chief instructor) at the R.A.F. Parachute Training School at Ringway, Manchester, where he remained until he left the Service at the end of the war. He rejoined the R.A.F. in 1947 and was appointed to command No. 1 Parachute Training School; and in 1953 he became O.C. the R.A.F. School of Physical Training.

IN BRIEF

Sir Archibald McIndoe, the distinguished plastic surgeon, is to broadcast on behalf of the R.A.F. Benevolent Fund on Battle of Britain Sunday (September 21) when he makes the Week's Good Cause appeal in the B.B.C. Home Service.

* * * * *

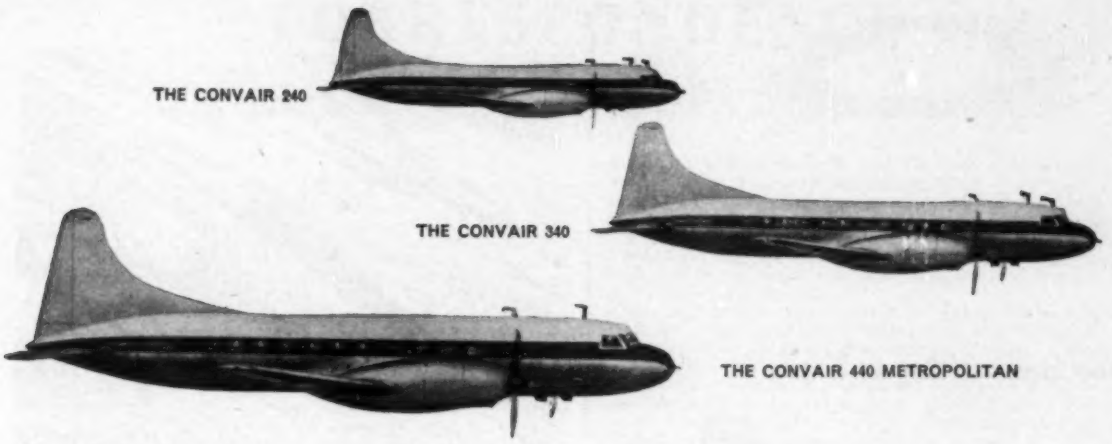
Fifty U.S. and Canadian air cadets and ten from Continental countries are today (July 25) starting on tours of the U.K. as guests of the A.T.C.

* * * * *

No. 60 Sqn., based at R.A.F. Tengah and equipped with Venom F.B.4s, recently completed ten years' operational flying against the Malayan terrorists and 38 years' service in the Far East.

* * * * *

Five R.A.F. aircraft storage units are due to be closed between the end of March 1959 and during the second half of 1960—No. 47 M.U. Hawarden, Ches; No. 10 M.U., Hullavington, Wilts; No. 12 M.U., Kirkbride, Cumberland; and No. 20 M.U., Aston Down, Glos.



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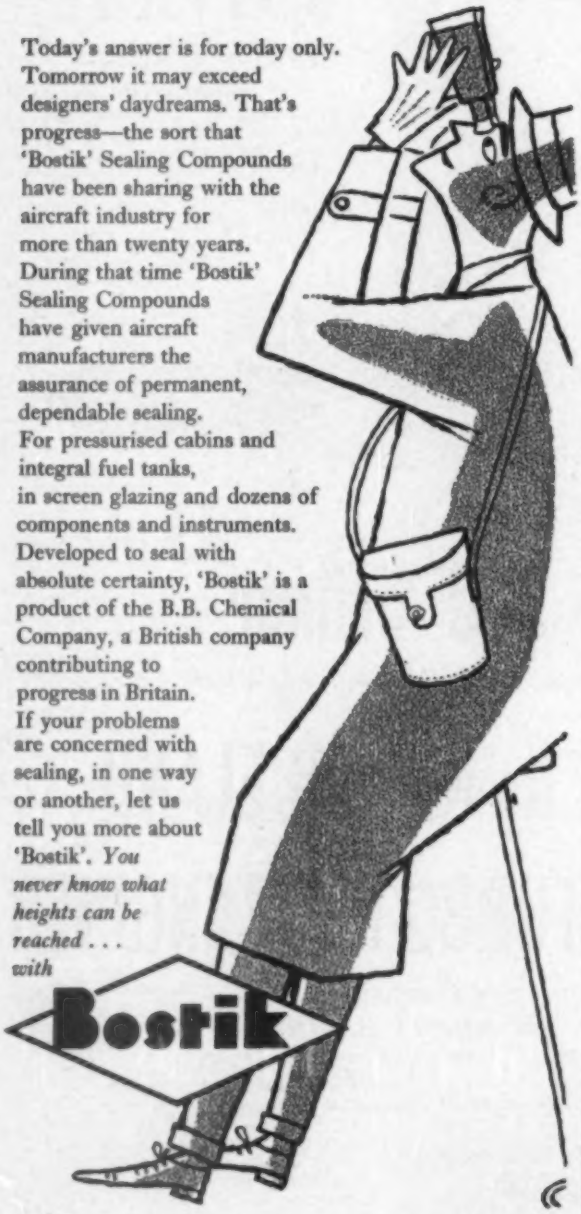

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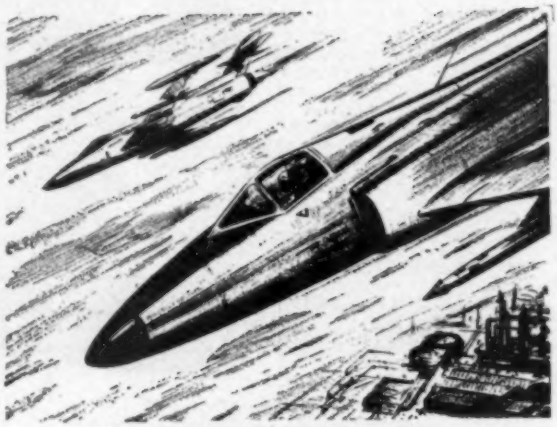

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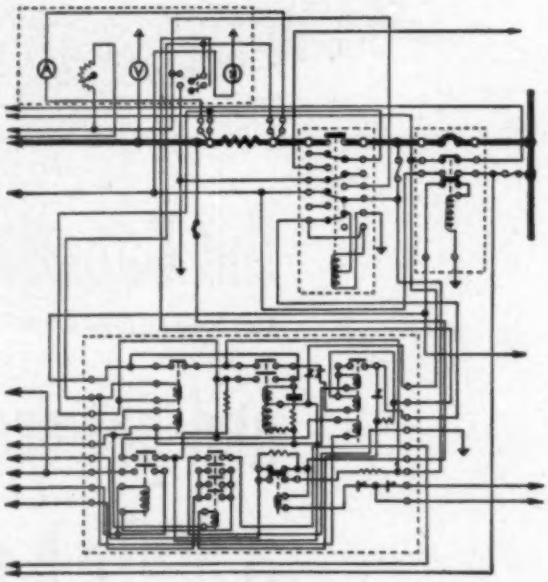

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CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

P.R. in 1939

I AM delighted that the letter from S/L. Everest in your issue of July 11 draws attention to the photographic reconnaissance work done by the Extended Reconnaissance Flight of No. 224 Sqn. in 1939, and I only wish he had gone into more detail.

The scope of my book *Evidence in Camera—The Story of Photographic Intelligence in World War II* had to be limited, as I was working to meet a deadline. So, as regards the photographic reconnaissance of the 1939 period, I purposely concentrated most of my research upon the developments which had the greatest significance for the whole war, i.e., the work of the unit at Heston, which was, of course, the nucleus from which the successful new photographic reconnaissance units came into being.

Inevitably this meant many heart-breaking omissions from my book, or bare mentions when the facts called for pages or chapters. For instance, I could only allude in passing to the work of Bomber Command's squadrons of photographic reconnaissance Blenheims.

May I take this opportunity of saying how sorry I am that throughout my book, not only at the beginning, much of importance and interest had to be omitted? But if I had tried to include everything the book would have become a record of a different variety, and I would still be writing it.

Cambridge. CONSTANCE BABINGTON SMITH.

A Fighter's Glide

IN "Hot from the States" (July 11, 1958) you write of the F-104: "Gliding 'clean' at 275 kt the F-104 loses 1,000ft of height every six air miles." This gliding ratio of 31 is exceeded only by the best sailplanes and cannot be true for a highly loaded fighter. Calculations for a typical sailplane and fighter show:—

	Sailplane	Fighter
For aspect ratio	20	5
and profile drag coefficient	0.01	0.01
and wing loading (lb/sq ft)	4	100
Best gliding ratio	36	6
at speed (knots)	40	275

To achieve a gliding ratio of 31 on a fighter such as the F-104 would need either a powerful imagination or about two tons of engine idling thrust.

Bath, Somerset. ALAN YATES.

[The figure was obtained from one of the F-104 pilots at Liége. He stated that the aircraft had a gliding ratio of 6:1 and defined this as a loss of 1,000ft for every six nautical miles. It should, of course, be a loss of one mile of height for every six miles flown, i.e., 6,000ft for six miles.—Ed.]

Handley Page History

HANDLEY PAGE, LTD., the first company to be constituted exclusively for the design and construction of aeroplanes, will have been in existence for half a century by the middle of next year.

A book, recording the company's history as completely as possible, will be published to mark this occasion.

May we ask any of your readers with records, photographs or memories relating to Handley Page, Ltd., and its aircraft to get in touch with us?

Cricklewood, London, N.W.2. S. A. H. SCUFFHAM, Handley Page, Ltd.

The Cody Man-Lifting Kites

YOUR correspondent B. J. Hurren has introduced another interesting historical point by asking, in your issue of July 4, who made the first ascent on Cody's man-lifting kites. At this period of time it may be difficult to establish. I can, however, add a small piece of history about these kites, which relates more to their end than their beginning.

At some point, possibly when he transferred his interest to aeroplanes, S. F. Cody gave all his kites to S. F. Edge, the motoring pioneer, who would have been with Napier at the time, and Edge later stored them in a shed in the grounds of his house in Sussex. In the spring of 1919, when I was a schoolboy, my family being close neighbours of S. F. Edge, the great man asked me one day whether I would care to have one of these kites to fly. He then described how they had been in his possession since (presumably) before Cody's death. He also mentioned the method of operation, which was to suspend several kites one above the other, the passenger being carried somewhere below the lowest kite. Of course, I was fascinated at the idea, and there and then S. F. Edge took me down to the shed at Gallops, where there was a pile of kites, by this time somewhat faded and with the fabric in some cases torn. Mr. Edge selected a sound example which, compared with my toy kites, seemed excitingly large, with a length and span of about 8ft, and for some weeks afterwards I had a lot of fun flying this device, which developed such a pull that it had to be secured to a stout fence.

The only thing to add to this little story is that shortly afterwards Mr. Edge came to tea with my parents at Streat, and I arranged to have the kite airborne for the occasion. On entering the house Mr. Edge asked, as expected, how the kite was going and I was able to indicate it about half a mile away, nicely visible through the drawing-room window. Unfortunately, during tea, the wind dropped, and the much-prized kite descended into a tall elm tree, from which it was impossible to extricate it.

Mrs. S. F. Edge is now living at Eastbourne, and I hope to ascertain whether she can throw any light upon early Cody kite-fodder—and also, perhaps, upon what happened to that store of kites in Sussex.

London, S.W.1. G. N. TORRY (Cdr. R.N.).

Poole Identification

WITH reference to John Gaylard's letter "Last at Poole," in your June 20 issue of *Flight*, I was responsible for servicing the unidentified aeroplane referred to.

It was, in fact, a French aircraft of plywood construction, and, I believe, originally based on the submarine *Surcouf*. With the fall of France the aircraft (with its crew of two) was transferred, or loaned, to the Royal Navy and renamed *Petrel*.

One interesting point about this aircraft is that it defied all attempts by the French pilot to become airborne from Poole harbour, until it was eventually flown by one Lt. Goldsmith, R.N.V.R., who then, presumably, passed on the "gen" to the Frenchman.

Also at Sandbanks were "booted" Swordfish.

R.N. Air Station Culdrose. K. W. CLARK.

Appointing an Air Correspondent

"DO you think an air correspondent's job needs more than a superficial knowledge of aviation?" This question was put to me during a preliminary interview for an appointment as B.B.C. air correspondent. My reply was that in an interview with an aeronautical specialist, for example, background knowledge should succeed in drawing him out, whereas ignorance might make him impatient and unco-operative.

In the B.B.C.'s recent announcement that a correspondent has now been appointed, a feature is made of his lack of aeronautical experience which, he hopes, will help him to interpret aviation matters more clearly for the ordinary public. This is certainly a point of view—although it seems to overlook the fact that experienced air correspondents on popular newspapers would not keep their jobs if they failed to interpret aeronautical news within the understanding of the ordinary reader.

If the B.B.C. wanted to make an internal appointment from their newsreel staff, why go to the bother of advertising the vacancy widely, and stipulating in the advertisement as the two essential qualifications: a trained journalist and an aeronautical background?

Exhaustive preliminary interviews, lasting about ninety minutes, ranged from opinions on the Press handling of the Munich air disaster, and on influences causing changes in NATO aircraft orders, to outlining a ten-minute television newsreel programme on the Rotodyne flight. About fourteen survivors were then invited to attend a written and recording test. The waiting room that day resembled a Press conference of the aircraft industry or Ministry of Supply. There were air correspondents from well-known London and provincial newspapers, and Press officers from the aircraft industry and the Air Ministry.

Looking around, I thought there were at least ten good men who could have filled the post admirably. I doubt if anyone rated his chances highly in the face of such top-line competition. Two strangers in the aeronautical midst—from the B.B.C. newsreel staff—aroused some misgiving; but generally there was a feeling of approval that this time the B.B.C. had decided to advertise the post, and were seeking a man of aeronautical experience for the job.

(*Continued at foot of page overleaf*)

Mr. H. Lazell, on retiring after 42 years with Cellon, Ltd., of which he was joint managing director, is congratulated by the chairman, Mr. J. D. Ferguson (left). In the right-hand picture Mr. Ferguson presents to Mr. W. J. Shilcock (joint managing director) an engraved gold watch. Similar mementoes, marking 30 years' service, went to Mr. Lazell and two other directors, Messrs. N. F. Rose and W. F. Wilson, and to 27 other members of the organization, serving and retired. The occasion inaugurated a "30-year club."

THE INDUSTRY

Mr. T. J. R. Smith has been appointed sales manager of Hellermann, Ltd. Since the spring of 1957 he has been manager of the company's solderless connectors division.

* * *

Firth Vickers Stainless Steels, Ltd., have won a diploma awarded by the annual congress of the European Investment Casters Association for a casting "showing the greatest promise for widening the scope of the investment casting technique."

* * *

Mr. G. E. Sugden has been made sales manager of Ketay, Ltd., an appointment described as "a major development in the company's plans for establishing sales representation throughout the country." He was previously with the Sperry Gyroscope Co., Ltd., having been assistant manager of their aeronautical department since 1951.

* * *

Firth Cleveland Instruments, Ltd., a subsidiary of Simmonds Aerocessories, Ltd., in the Firth Cleveland group of companies, have concluded a licensing agreement with the Gilbert and Barker Manufacturing Co., West Springfield, Mass, to manufacture and market the Gilbarco storage-tank electronic gauge. This is said to have recorded greater level-accuracy than + or — 1/16in on installations in the U.S., with + or — 1/64in obtainable in the laboratory. It can be installed in tanks of all types at temperatures up to 425 deg F, and in underground locations down to depths of 1,000ft.

* * *

The Board of Helliwells, Ltd., have decided to liquidate the company's aircraft division. In a statement announcing this the directors say that "unfortunately, since the Government White Paper on Defence last year, we have suffered a steadily deteriorating demand for our capacity, and as the future position does not indicate any substantial improvement we have been obliged to cease our aircraft activities in order to curtail further heavy losses."

* * *

Mr. David J. Hill has joined the de Havilland Aircraft Co. (Pty.), Ltd., of Australia as a commercial sales representative and will handle the sales of Beavers, D.H. and Lycoming engines and a wide range of propellers. It is also reported from Australia that three Beavers operated by Aerial Agriculture Pty., Ltd., spread 12,000 tons of superphosphate in N.S.W. country areas between January 1 and April 30. Over the same period last year 14 Tiger Moths were used to spread a similar amount.

CORRESPONDENCE (continued from page 153)

We sat at a large table with sheets of paper and sharpened pencils in front of us, and the examination paper was handed round. We had two hours to write a four-minute script of 600 words on one of a number of subjects which included the Firestreak; the P.1; a programme for the anniversary of a well-known aeronautical company; likely civilian aviation developments; and the factors likely to influence the rôles of manned aircraft and ballistic missiles in U.K. air defence policy between now and 1965. A girl secretary stayed in the room, presumably to see that no one used a crib!

We recorded our scripts, and in the afternoon attended an appointments board consisting of an appointments officer (in the chair); Mr. E. R. Thompson, head of B.B.C. news talks; and Mr. E. T. Jones, of the Ministry of Supply, as the aeronautical expert. After this there was another appointments board for a final half-dozen candidates.

Presumably the experienced air correspondents were marked down on the domestic and technical television questions, which eventually drew from me a protest. For instance, one question asked was: "If you had to cover for both sound and Television Newsreel an interview with the Minister of Supply, would you take a sound recording unit along with you, as well as a television film team, or would you use the sound-track from the tele-recording in the radio newsreel?"

I protested that whether it was practicable to use the same sound track or to make a copy of it was a matter of domestic procedure which the appointed candidate could reasonably expect to be told.

Perhaps the B.B.C. decided it was easier for a man with newsreel experience to pick up aviation as he went along than for an experienced air correspondent to acquire radio and television newsreel technique. Even so, among the air correspondents were men who have broadcast on occasion, and done commentaries for the crowd at air shows.

I write with no ill-will towards the selected candidate, who is personally unknown to me, and with no feeling of "sour grapes"; for although I should have liked the job I had mentally ruled out my chances when I saw some of the other candidates whose qualifications I knew.

If not particularly highly paid, the post of B.B.C. air correspondent is certainly one of the most responsible in aviation journalism. As a writer deeply interested in air matters and the welfare of Britain's aeronautical development, I do think it regrettable to see the B.B.C. following an unfortunate Government precedent of appointing men without specific technical experience to positions of responsibility in specialist fields.

London, W.1. JOURNALIST.

[On June 27 the B.B.C. announced that to succeed Mr. Ivor Jones as air correspondent it had appointed Mr. Reginald Turnill, its assistant industrial correspondent since May 1956. "I am hoping that as a non-technical man I might make a useful link between the industry and the public in my new job," he is quoted as saying.—Ed.]

Patents and Publication

DR. LOCKWOOD TAYLOR'S independent conception of the camber line for aerofoils was no less his own secret, to divulge as he thought fit, because the N.A.C.A. happened to be working on similar lines.

If his ideas on "air-lubricated ships" (Correspondence, *Flight*, July 11) turn out to be the same as those which are being put into hardware by others, so much the better. Let the latter extract their digits!

Moreover, such publications by a professor of aeronautics obviously are more valuable than any by "lay" inventors, not only because they command respect but also for their development of detail.

Kingston-on-Thames, Surrey. R. COX ABEL.

FORTHCOMING EVENTS

July 26. R.N. Air Station Lossiemouth, Morayshire: At Home.
July 26-27. Trente and Bolzano Aero Clubs: Dolomites Circuit.
July 26-Aug. 4. B.G.A.: National Soaring Week.
Aug. 1-16. Czech Aero Club: World Parachute Championship, Bratislava.
Aug. 2. R.N. Air Station Brawdy, near Haverfordwest: At Home.
Aug. 2-4. Plymouth Aero Club: Rally.
Aug. 2-5. S.M.A.E.: Model Aircraft World Championships, College of Aeronautics, Cranfield.
Aug. 9. R.N. Air Stations Yeovilton, Somerset, and Lee-on-Solent, near Fareham, Hants: At Homes.
Aug. 16-17. Alsace Aero Club: Rally des Vins, Alsace.
Aug. 31. Oxford Aeroplane Club: At Home, Oxford Airport.
Sept. 1-7. S.B.A.C. Display and Exhibition, Farnborough.
Sept. 8-13. International Congress of Aeronautical Sciences, Madrid.
Sept. 21. B.G.A.: National Sailplane Aerobatic Contest, Dunstable.
Sept. 21. Royal Belgian Aero Club: 300 cu m Balloon Competition.
Sept. 21. Milan Aero Club: Rally.
Sept. 26-29. Austrian Aero Club: Innsbruck Rally.

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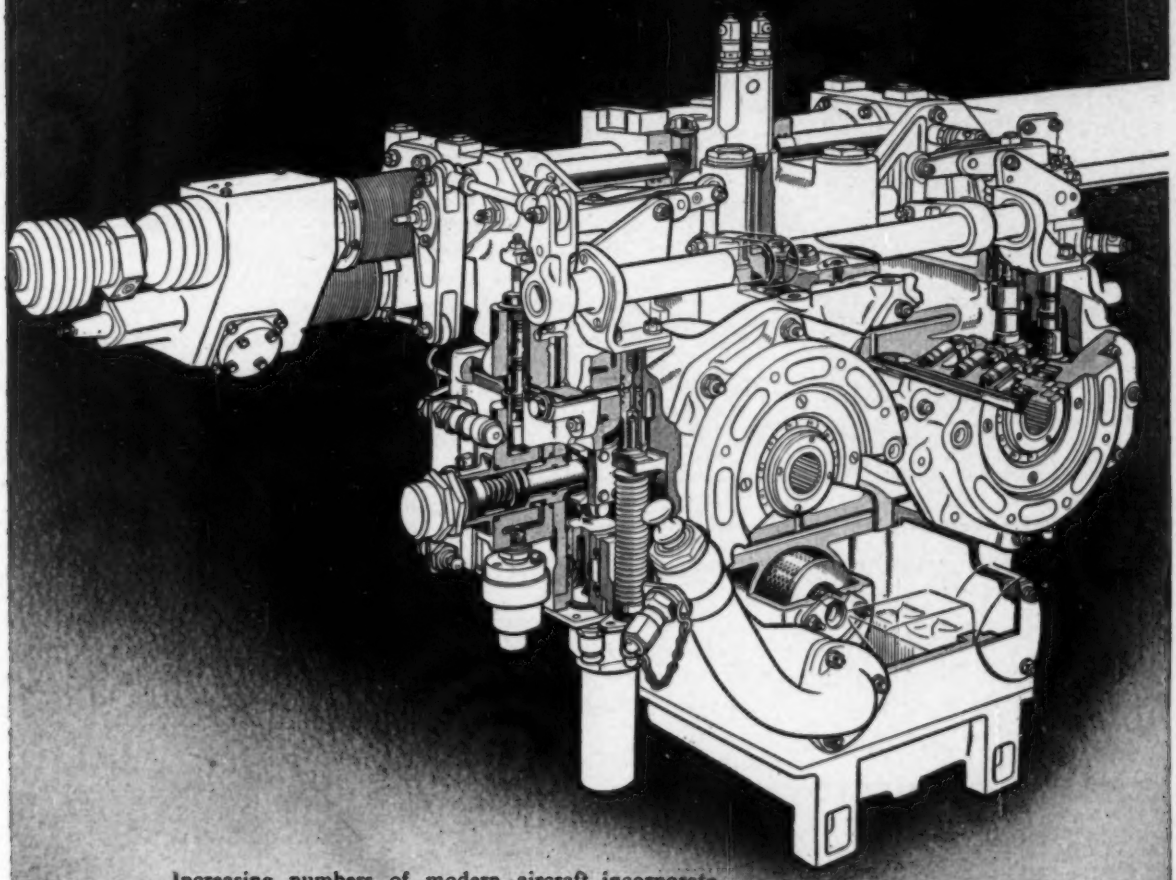

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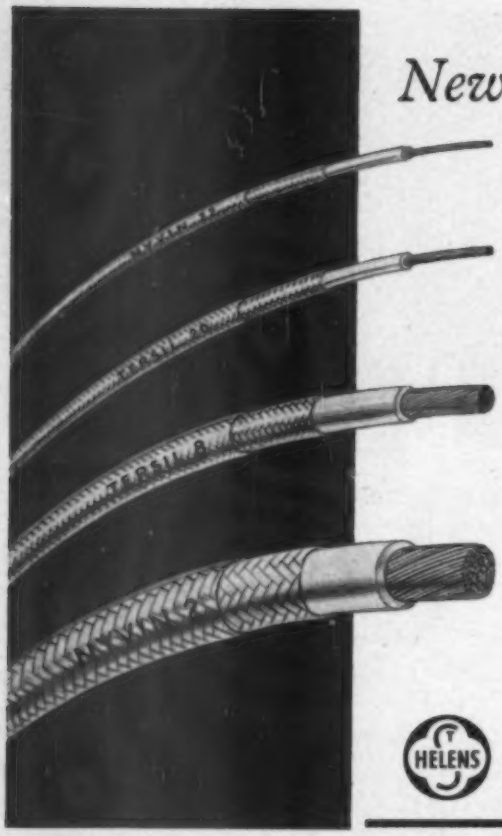

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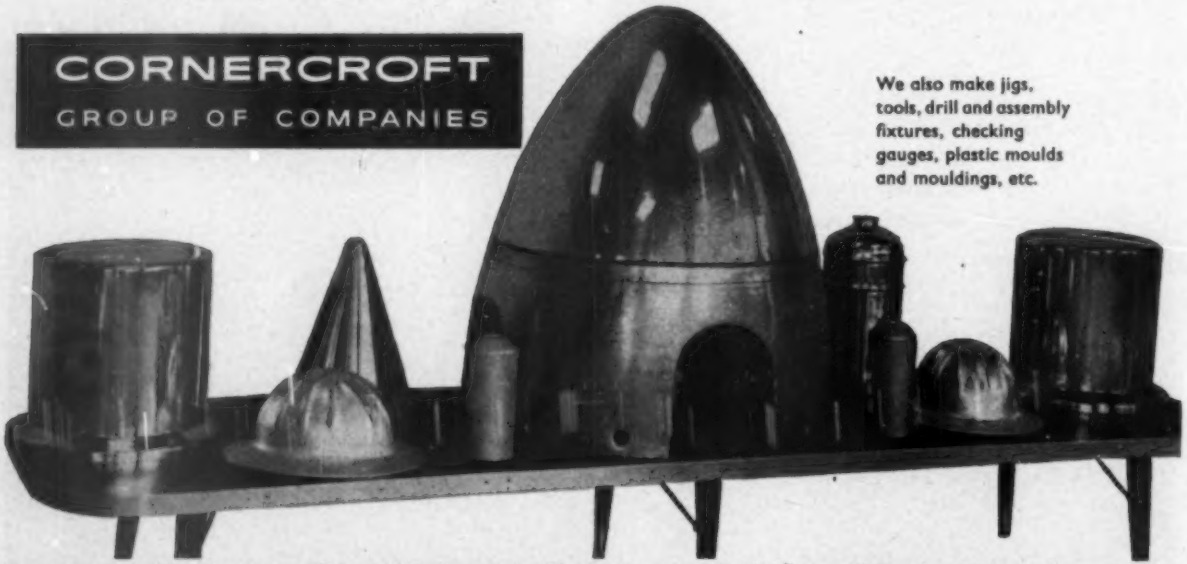

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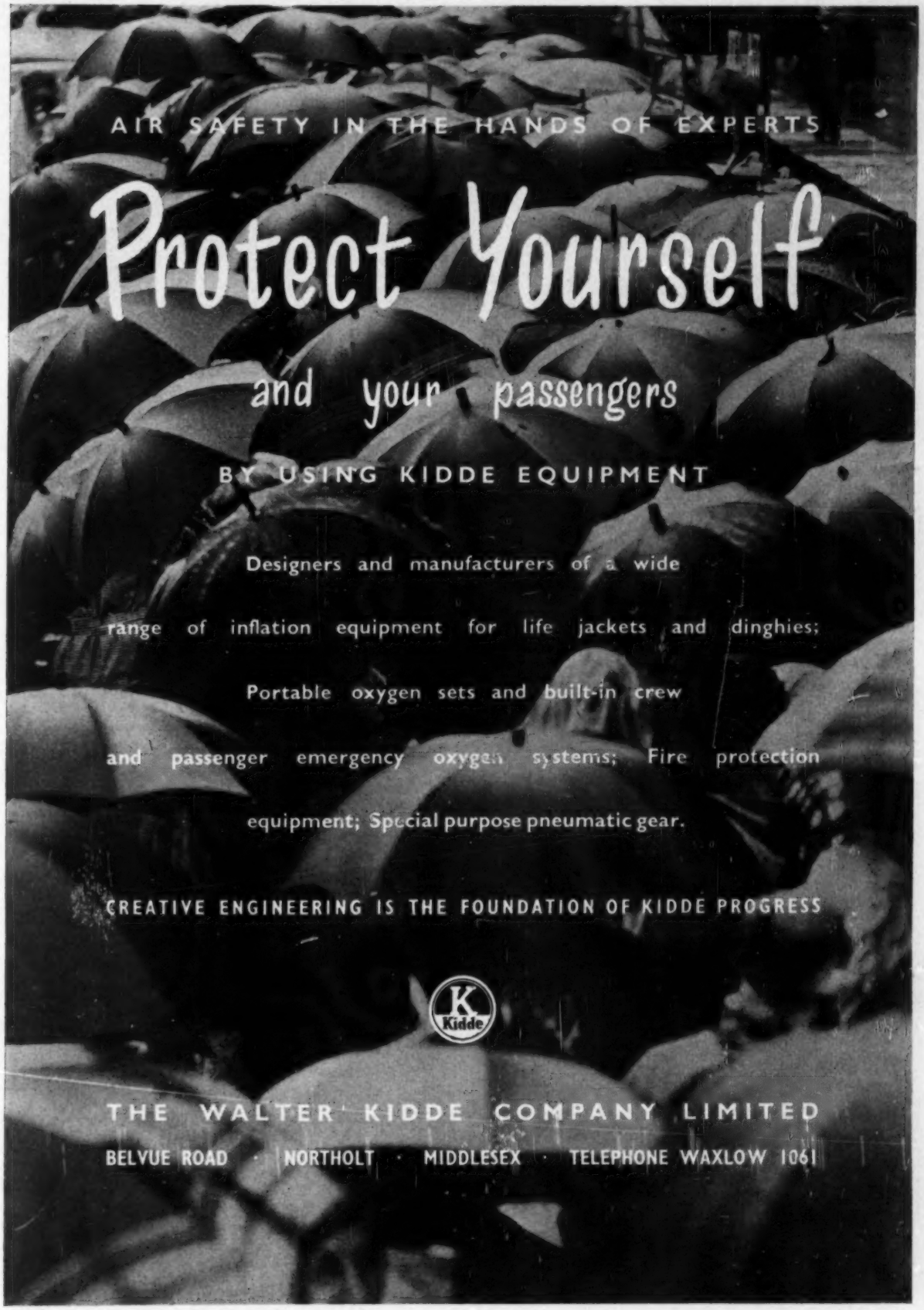
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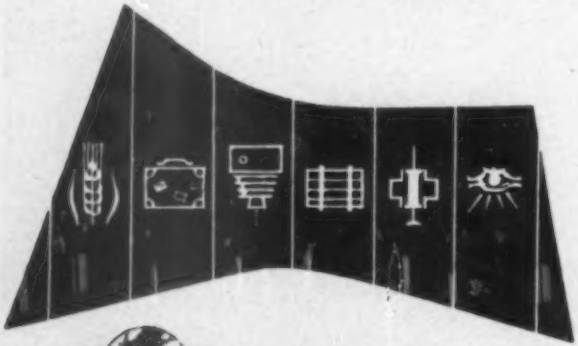

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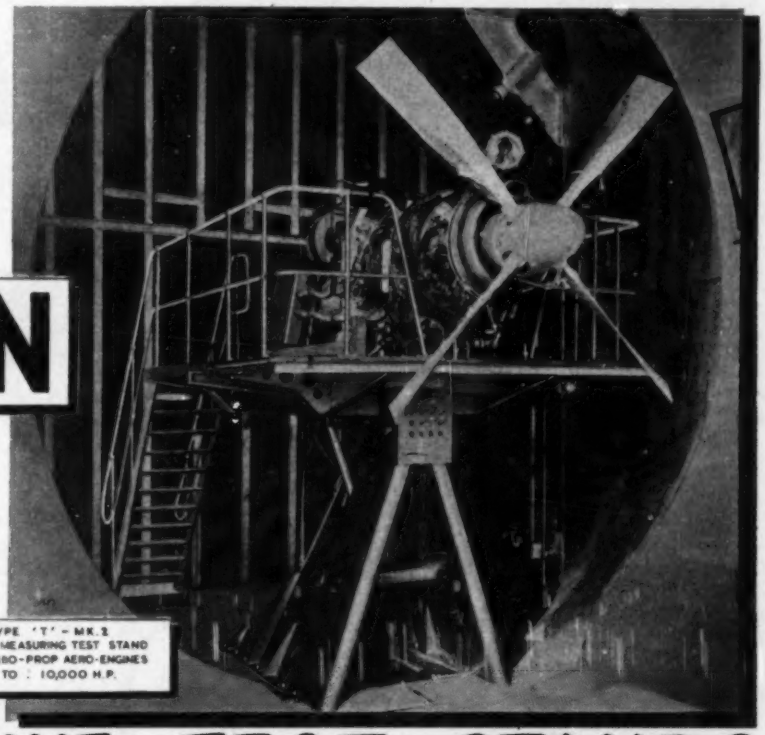

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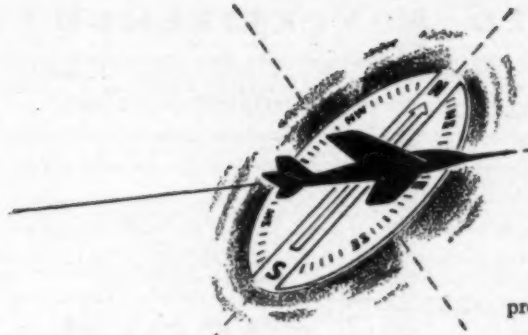

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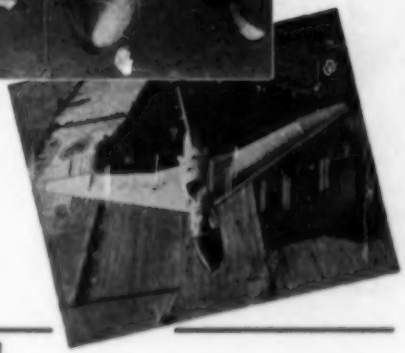

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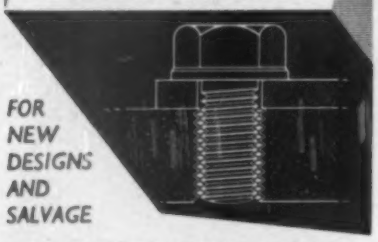

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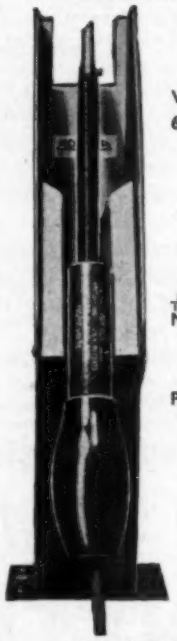

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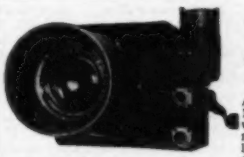

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APPLICATION No. 766/2 for an amendment to the terms of approval of the Normal Scheduled Service which they are authorized to operate on the route Manchester (Ringway) - Hamburg - Copenhagen so as to permit them to operate on the route Manchester - Hamburg and/or Copenhagen and/or Stockholm.

APPLICATION No. 1377/1 for an amendment to the terms of approval of the Normal Scheduled Service which they are authorized to operate on the route Manchester (Ringway) - Stavanger (opt.) - Bergen (opt.) - Oslo so as to permit them to operate on the route Manchester - Stavanger (opt.) - Bergen and/or Oslo.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [8116

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NOTICE is hereby given that Societe Rateau and Rene Anxionnaz seeks leave to amend the Complete Specification of Letters Patent No. 650,661 for an invention entitled "Reaction propelling device for aircraft."

PARTICULARS of the proposed amendments were set forth in the Official Journal (Patents), No. 3,622 dated 16th July, 1958.

ANY person may give Notice of Opposition to the amendment by leaving Patents Form No. 36 at the Patent Office, 25 Southampton Buildings, London, W.C.2, on or before 16th August, 1958.

GORDON GRANT
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NOTICE is hereby given that Societe Rateau and Rene Anxionnaz seeks leave to amend the Complete Specification of Letters Patent No. 650,710 for an invention entitled "Improvements in or relating to jet reaction propulsion units for aircraft."

PARTICULARS of the proposed amendments were set forth in the Official Journal (Patents), No. 3,622 dated 16th July, 1958.

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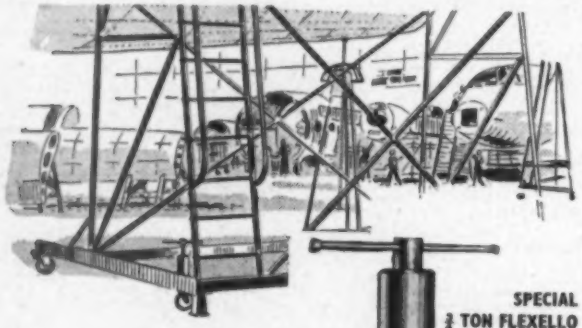

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Reporting on the first three and a half months of Britannia operation, Sr Vargas said that Aeronaves had not had a single delayed schedule due to engine trouble. "This," says Sr Vargas, "has set *a new standard of mechanical reliability* for engines in our airline and has inspired our aircrew with great confidence."

Proteus requires minimum maintenance

"Our maintenance personnel too," continues Sr Vargas, "are well satisfied, since the minimum of daily maintenance is required by these engines."

"Because of this, we in Aeronaves consider the Bristol Proteus to be the nearest approach to the *ideal propulsion unit for transport aircraft*."

The Proteus is extremely suitable for air transport, because its mechanical excellence and exceptional reliability ensure long, trouble-free life. It is the most powerful jet-prop in airline operation and has the lowest specific fuel consumption of any gas turbine in service.

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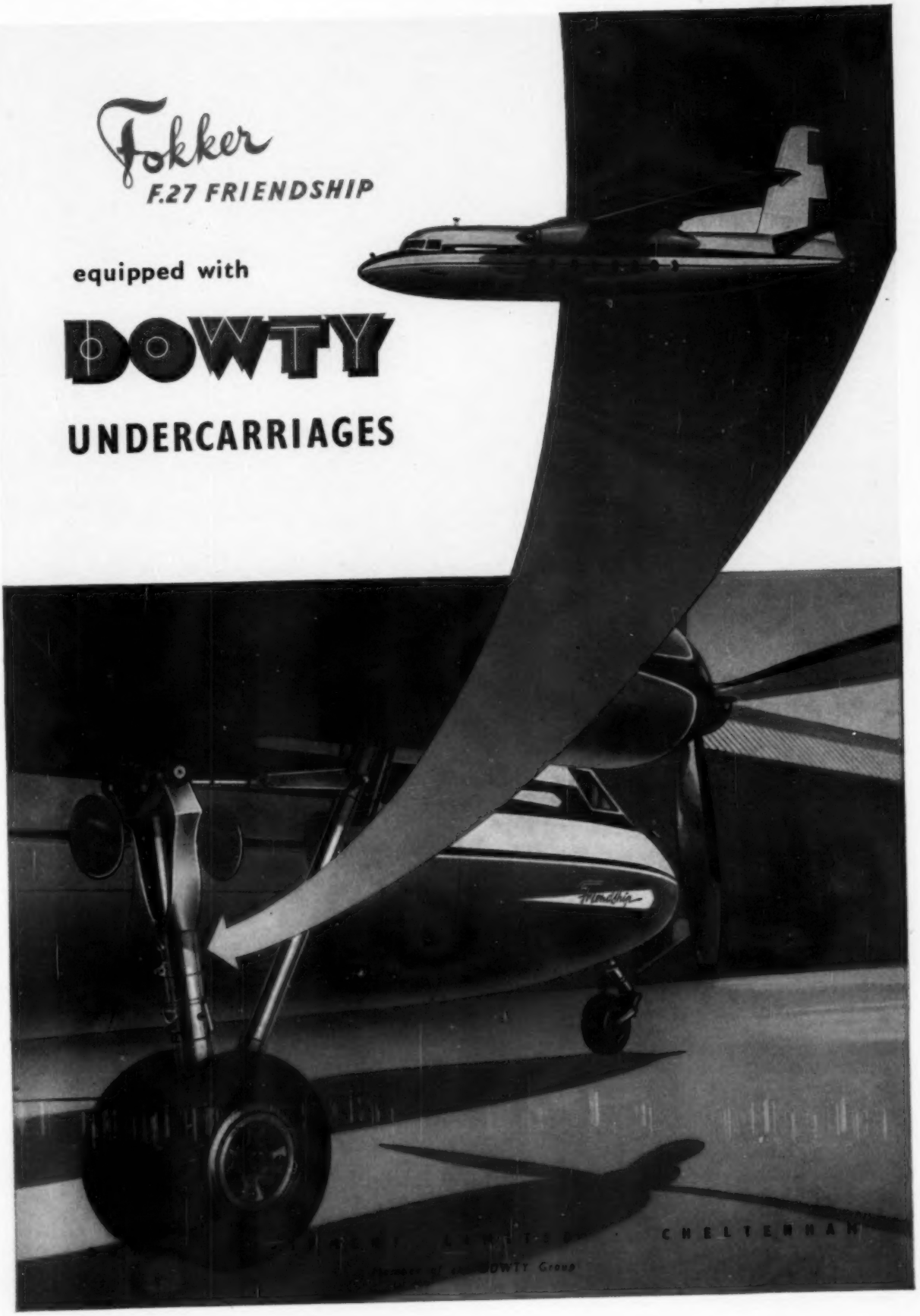

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